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FETAL SWALLOWING, GASTRO-INTESTINAL ACTIVITY AND DEFECATION IN AMNIO

An Experimental Roentgenological Study in the Guinea Pig

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THAT amniotic fluid may be swallowed by the fetus and that it may serve some nutritive function in the growth process during intra-uterine existence is not a new idea. Ever since Preyer's account in 1885, various investigators have discussed the possibility but, until recently, we have had very little experimental proof that swallowing of amniotic fluid is a normal physiological function of the fetus.

In his *Physiologie des Embryo*, Preyer wrote: "That amniotic fluid is a food for the fetus is certain, but if it is not swallowed plentifully, it contributes little to nourishment beyond mere water feeding, a fact which follows from its slight specific gravity." Minot was essentially in agreement with Preyer in regarding the amniotic fluid as the chief water supply of the fetus. He summarized the work of Needham, Haller, Moriggia, Doederlein and others who pointed to the presence of epithelial cells, lanugo hair and vernix caseosa in the digestive tract as evidence indicative of the swallowing of amniotic fluid.

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Other evidence in the past has come from various types of injection experiments. These have been largely indirect in that chemicals or dyes injected into the maternal blood stream were sought for in the amniotic fluid and in fetal tissues. Of late, direct injection into the amniotic cavity has been used. Preyer reported such experiments, but the object of them was to determine the source of amniotic fluid rather than to seek proof of fetal swallowing. Nevertheless, an analysis of some of these investigations (5, 8, 15, 23) seems to indicate that fetal swallowing occurred often.

In order to find out approximately how much the fetus urinated into the sac, Fehling administered sodium salicylate or potassium ferrocyanide twice daily to pregnant women near term. In 3 of 17 such cases, he found the potassium ferrocyanide in the amniotic fluid but the urea content of this fluid was less than 1.0 per cent. Furthermore, he was unable to pick up potassium ferrocyanide in the first urine passed by the newborn although it was present at the second urination in 3 cases. Sodium salicylate was readily obtained in the first urine of the child.

Fehling's work suggests that the fetus may have swallowed amniotic fluid and in this

manner obtained the chemicals which were found in the urine of the newborn. It is not necessary to conclude that they were passed into the amniotic fluid as a product of fetal urination. Rather, the salts could very well have arrived in the amniotic fluid by way of the placenta and fetal blood stream and diffused through the fetal membranes.

Zuntz (23) injected an aqueous solution of sodium indigosulphate into the jugular vein of pregnant rabbits. Very shortly thereafter, the amniotic fluid became colored blue although no part of the fetus, neither the kidneys nor the urine in the fetal bladder contained a trace of the dye. To make doubly sure that no dye passed into the amniotic sac via the fetus, several fetuses were killed *in amnio* by injecting them with concentrated potassium hydroxide before the dye was introduced into the mother's vein. Again the same blue color appeared in the amniotic fluid. In similar experiments, Wiener (15) demonstrated that only the maternal side of the placenta and the fetal membranes became colored by the injected material. The fetal placenta remained uncolored. Similarly, Krukenberg consistently demonstrated the presence of potassium iodide in the amniotic fluid but only occasionally in the fetal kidney after administration by mouth to pregnant women near term.

In none of these experiments was injection made directly into the amniotic sac. One of the earliest direct injection experiments is that by Wiener (16) who endeavored to demonstrate functional resorption by the fetal intestine. He introduced a 5 to 10 per cent solution of calcium ferrocyanide into the amniotic cavity of rabbit and dog fetuses. Two to 3 hours later tests were made with ferric chloride, and the chemical found in all the fetal tissues, especially the walls of the stomach, intestines, mesentery, kidney, and skin. He thought the fetuses were swallowing actively and regularly and that absorption could have taken place by the stomach alone, but possibly did also occur through the skin and surface of the umbilical cord.

In 1921, Wislocki demonstrated that colloidal dyes, such as trypan blue, when injected during the latter part of pregnancy into the amniotic cavity of guinea pig and cat fetuses, were absorbed by three routes: through the gastro-intestinal tract by swallowing, by aspiration into the respiratory tract[1], or by diffusion through the amnion.

If it has been difficult to make a case for fetal swallowing upon the evidence from indirect injection experiments, the answer to the question is still not entirely contained in the work of Wiener (16) and Wislocki. Both investigators employed a general anesthetic and performed laparotomies in which manipulation of the uterus and its contents is often unavoidable. Hence, granting that swallowing did occur under such conditions, one is not justified in assuming that it is a normal physiological function of the fetus. We have discussed effects of anoxemia on fetal behavior elsewhere (18).

DeSnoo, in 1937, described an ingenious treatment of polyhydramnion by apparently accelerating the swallowing of amniotic fluid. He reported having successfully treated several women by injecting 80 cubic centimeters or more of a saccharin solution of 50 tablet strength into the amniotic cavity after first withdrawing an equal volume of amniotic fluid. These injections directly through the abdominal wall of the mother were performed with little difficulty under local anesthesia. The girth of the maternal abdomen gradually decreased as did the distance from the symphysis pubis to the xiphoid process. Previous symptoms such as dyspnea and orthopnea disappeared and the fetus once again became palpable by ballottement. The infants delivered were normal in every respect. Saccharin was found in the blood of the umbilical cord and in the first urine of the child. DeSnoo attributed the reduction of polyhydramnion to an increased incidence of swallowing *in amnio* brought about by the presence of a sweet stimulus. In a single case in which no reduction followed such treatment, an apparently normal child was delivered, only to wane and die on the fifteenth day as a result of an atretic esophagus.

Using the same technique, DeSnoo subsequently injected methylene blue into the amniotic cavity along with the saccharin. A per-

[1]For a discussion of aspiration of fluid *in amnio* see our earlier report 17)

manent catheter was inserted into the maternal bladder and urine samples were collected regularly. In this way any dye coloring the urine would give some indication of the rate and regularity of swallowing *in amnio*. The dye was readily absorbed in the fetal intestine, carried into the maternal blood through the placenta whence it was excreted by the mother's kidneys. The fetal membranes were found to be impermeable to the dye. The quantity of methylene blue excreted by the mother varied from time to time as the amount and concentration of the maternal urine varied. Sometimes it would appear early after injection, in other instances late. Off and on, no dye was found in a urine sample, only to appear again in a succeeding sample. It follows that the fetus did not drink regularly but only at intervals. When the women were questioned, there seemed to be a correlation between amount of fetal movement and strength of coloration of the urine. DeSnoo concluded that "apparently the child sleeps for many hours *in utero* and, becoming wakeful, it begins to move and to drink the sweet amniotic fluid."

Ehrhardt recently reported an interesting experiment. He injected 8 cubic centimeters of thorotrast into the amniotic sac of a woman 6 months pregnant. Fifteen hours later, after a hysterectomy, x-ray films of the fetal membranes and their contents revealed beyond any doubt that the thorium was concentrated in the stomach and small intestines. Ehrhardt was probably not aware that Menees and his co-workers had previously obtained similar but less striking results after replacement injections of strontium iodide in 21 human subjects. Some of their x-ray films indicated swallowing by the appearance of a stomach shadow. The strontium iodide was absorbed rapidly, decreasing in density in 4 to 5 hours.

From the foregoing studies, it becomes increasingly evident that the fetus normally swallows fluid *in amnio*. The use of a local anesthetic, if it altered conditions at all, probably did not upset the normal physiological balance *in utero* as much as would a general anesthetic. When laparotomy was avoided and replacement injections used, the effects of increased pressure in the sac were minimized. Hence the condition of the fetus in these later experiments was probably nearly normal. From the standpoint of suitability of the injection mass, colloidal thorium dioxide is a better material than strontium iodide. It is believed to be practically inert physiologically[1] and is not absorbed in the intestinal tract. Since it casts a good shadow on the x-ray films, its passage can be followed easily at all times. Unfortunately the progress of the swallowed fluid was not observed over long periods of time by Ehrhardt and Menees. Nor has there been any attempt to discover just when swallowing and gastro-intestinal activity begins in fetal life. All the fetuses studied were near term except Ehrhardt's 1 case. In other words, there has been no genetic approach to the problem of the development of swallowing and gastro-intestinal motility *in amnio* by roentgenological methods. Studies in the past have approached the developmental problem in other ways but most of them were carried out under conditions of at least partial asphyxia, a fact which must be considered when applying the data to the state of visceral motility in the normal undisturbed fetus *in utero*.

In human fetuses, movement of the stomach musculature may be implied from the presence of amniotic constituents in the meconium as early as the fourth or fifth month. Several workers have observed gastric motility directly when the stomachs of mammalian fetuses were exposed. To what extent asphyxia induced by experimental procedures influenced these movements has not been determined.

Tani reported gastric movements in rabbit and human fetuses, and observed that adrenalin accelerated such activity in the rabbit but retarded it in the human. Friedman observed stomach motility in 58 millimeter cat fetuses. Windle and Bishop (19) noted spontaneous gastric movements in 35 millimeter cat fetuses (roughly comparable with the 12 week human). By 70 millimeters the behavior of the stomach appeared no different from that found in unanesthetized kittens a day or two old (120 to 140 mm.). Rhythmical peristalsis began on the fundic side of the pyloric antrum and spread over the pylorus. Rapid emptying of the stomach into the duodenum was encountered.

[1]We do not wish to imply that safety of use in human subjects has been proved.

Fig. 1. Guinea pig No. 21, forty-sixth day after copulation.[1] One amniotic sac is outlined by 0.6 cubic centimeter of colloidal thorium hydroxide. Film taken immediately after injection and before swallowing by the fetus.

We have recently observed similar motility in late cat fetuses. The rapid passage from the stomach to the duodenum is all the more apparent if the fetus has swallowed air during delivery. The bubbles can be followed readily through the transparent gut wall. One of the present authors (W.F.W.) has occasionally seen regurgitation of the stomach contents during the last third of gestation in cat fetuses. It seemed to be accompanied by marked respiratory effort and probably was caused by respiratory compression of the abdominal contents. Using the balloon technique, Carlson and Ginsburg recorded vigorous and frequent hunger contractions in 8 to 10 day prematurely delivered puppies.

Since Preyer's review of the subject in 1885, little has appeared in the literature concerning fetal intestinal motility. In 1907, Yanase (21, 22) reported experiments on human and guinea pig fetuses. He observed intestinal peristalsis in specimens freshly killed for which reason limited significance may be placed upon his developmental account. He reported peristalsis first on about the twenty-sixth or twenty-seventh day (19 mm.) in guinea pigs. This was correlated with the first appearance of the longitudinal muscular layer and its nervous elements. Before this time (15 mm.), only circular muscle had been laid down, and only local constriction of the gut could be elicited by pinching or by faradic stimulation. Furthermore, he claimed that until the eighth week (about 90 mm.) peristalsis was observed only when the fetus was immersed in a bath of Locke's solution at 38 degrees C. After 8 weeks, movements could be seen upon opening the guinea pig's abdomen in the air.

In the human subject, he was unable to observe peristalsis until the eleventh week though the longitudinal smooth muscle and its nerves had been present since the seventh week. During the sixth week, when only the circular layer was present, he elicited local contraction with a faradic stimulus. He believed that the early intestinal movements were of neurogenic origin.

Windle and Bishop (19) decerebrated pregnant cats by the anemia method and delivered their fetuses with placental circulation intact into a constant temperature bath of Locke's solution. They were able to induce local constriction of the intestinal wall in a few as small as 18.5 millimeters. Spontaneous movements appeared in 35 millimeter specimens, and the strength of peristalsis increased rapidly up to the 70 millimeter stage at which point in development intestinal activity resembled that of the newborn kitten. The movements caused segmentation and propagation of intestinal contents. It is important to note that even under experimental procedures in which an effort was made to preserve physiological conditions like those which obtain *in utero* all of the fetuses exhibited some anoxemia. Even under optimum conditions, blood gas analyses indicated an oxygen content in the umbilical vein of not more than 6.5 volumes per cent (about 50 per cent saturation). When this dropped to 2.1 volumes per cent, intestinal

[1]All ages calculated from time of vaginal membrane opening. Since birth did not take place in this animal until the seventy-second day, insemination probably failed to occur on the first days the membrane was open.

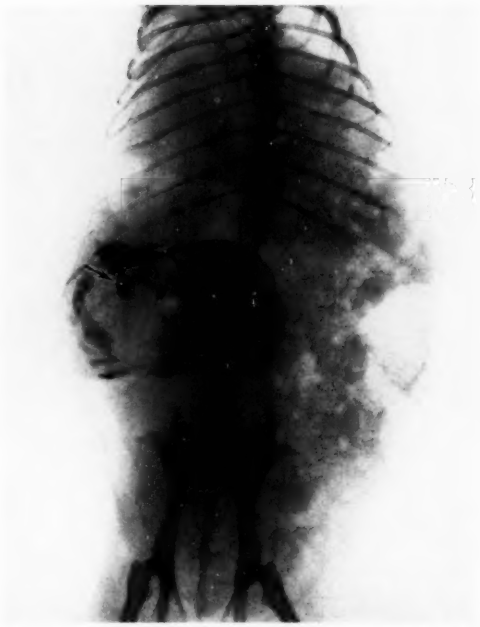

Fig. 2. The same pig, forty-seventh day. Some of the amniotic fluid has been swallowed; the thorium hydroxide can be seen in the fetal stomach (arrow).

Fig. 3. The same pig, forty-eighth day. The material now fills the stomach and has passed along into the small intestine.

activity diminished. When placental circulation was completely interrupted, muscle tonus diminished and writhing, pendulous movements replaced peristalsis.

Concerning defecation *in amnio* we have only our own observations to report. Although active peristalsis was commonly seen in the large bowel of experimentally delivered cat fetuses, the act of defecation was never observed while the intestines were exposed. When the animals were anesthetized before examining their fetuses, it was common to find large amounts of meconium in the amniotic sac. We have observed the passage of meconium into the sac in a few instances while delivering fetuses by cesarean section. Meconium is passed in the human at or shortly after delivery but the amniotic fluid does not contain it as a rule. After prolonged, difficult labor or in asphyxia neonatorum, meconium may be found in the bag of waters. We shall demonstrate that defecation does occur normally during the intra-uterine life of the guinea pig.

MATERIAL AND METHOD

Following Ehrhardt's technique we injected the amniotic sacs of 50 fetuses of 39 guinea pigs at various stages of gestation ranging from 37 days to term. In our colony, the average period of gestation ran about 66 or 67 days. The pregnant animals were fastened, back down, to an operating board and the position of the fetal head determined by palpation. Without using any anesthetic, a thin (No. 27) hypodermic needle was passed through the abdominal and uterine walls into the amniotic sac. On a few occasions no amniotic fluid was withdrawn, but usually a replacement injection was made with 0.4 to 1.0 cubic centimeter colloidal thorium hydroxide or dioxide (thorad or thorotrast[1]). Injections were made as near the mouth as possible. After injection, roentgenograms were taken within a few minutes, a few hours, and then at daily intervals until birth.

[1]We wish to acknowledge our indebtedness to the General Electric X-Ray Corporation and the Heyden Chemical Company who generously supplied us with these experimental materials.

Fig. 4. The same pig, fiftieth day. So much amniotic fluid has been swallowed that the sac is nearly clear. Material is concentrated in the stomach and intestines.

Fig. 5. The same pig, fifty-fourth day. The amniotic sac is clearer, the stomach nearly empty and the material is concentrated in intestines; segmentations may be seen.

RESULTS

With practice, the chances of missing the amniotic sac during injection are small. Of the 50 injections attempted, only 6 were unsuccessful, and these occurred during the earlier experiments. Positive swallowing and passage of the thorium through the gastro-intestinal canal occurred in 31 fetuses. There were 4 others in which swallowing was doubtful, questionable stomach shadows appearing only after several days. Six fetuses aspirated the fluid into the lungs after the mothers had been intentionally subjected to anoxemia (17) but there was no passage into the gastro-intestinal tract. Three young fetuses (37 to 38 days) retained thorotrast in their amniotic sacs but failed to swallow it any time during a 5 day observation period. In fact, fetuses injected before the forty-first day either were not observed to swallow the thorium at all or did not do so until the forty-third day. The earliest incidence of fetal swallowing as determined by the presence of thorium in the stomach was on the forty-second day, 24 hours after injection into the amniotic sac.

As will be seen in Table I, the fetuses which were studied may be grouped conveniently into three age brackets: those running approximately through the forties, those through the fifties, and those through the sixties in terms of days of gestation. Column 1 lists the serial number of the pig. The symbol, "A," after any number indicates that the pig was subjected to anoxemia immediately after the first film was taken. By anoxemia is meant either rebreathing, or breathing atmospheres with high carbon dioxide or nitrogen content. At the time, we were interested in discovering the effects of anoxemia upon aspiration of amniotic fluid (17). Since all but 6 of the fetuses of guinea pigs so treated swallowed amniotic fluid, they are included with normal specimens in this study. The effect of anoxemia upon gastro-intestinal activity will be discussed later. Column 2 of Table I indicates the age of the fetus at the time of injection.

Fig. 6. The same pig, fifty-seventh day. The intestines are now filled and show the presence of many segmentations. This condition was maintained until the sixty-first day.

Fig. 7. The same pig, sixty-first day, a.m. Defecation *in amnio* has occurred (compare the intestines with Fig. 6) and the meconium is mixing with the amniotic fluid to cause the sac to be outlined again.

Column 3 gives its age at the time thorium was first seen in the stomach; and following this the number of hours which had been required for the thorium to reach the stomach. It was not always possible to be sure just when this occurred unless many films were taken, but one can come reasonably close by exposing films immediately after injection and 2, 4, 6, and 12 hours later. Near term, it was essential to expose a film at least as soon as one-half hour after injection. In some cases, e.g., pig No. 14, the table reads "before 4," indicating evidence that swallowing had occurred well before the 4 hour film, for not only was the stomach outlined but also the small intestine. The rapidity with which thorium reached the stomach after injection increased with age. As Table II shows, this took about 36 hours in fetuses 39 to 46 days old, about 11 hours in fetuses 50 to 59 days old, and from 1.8 to 3 hours in those 60 to 68 days old. However, there were individual variations.

It becomes apparent from inspection of Tables I and II that the speed at which thorium passed to the small intestine likewise increases with age. The average passage times in the three age groups were 127.2, 37.3, and 16.4 hours, respectively. Table II indicates that the material reached the large intestine much earlier in fetuses near term than it did in the youngest age range. Accompanying this increase in rate of passage through the gastro-intestinal tract, the time required to swallow the entire fluid contents of the sac decreased with age. We determined the time taken to swallow all the thorium by noting the interval required for the sac to become clear after the first faint stomach shadow had appeared. Quite often by the time we obtained a roentgenogram showing a clear amniotic sac, the stomach shadow had disappeared too, leaving the intestines full of thorium. These data are recorded in Tables I and II.

Fig. 8. The same pig, sixty-first day, p.m. The fetus has begun to reswallow the fluid of the amniotic sac and a shadow can again be seen in the stomach (arrow).

Late in fetal life, usually not before the sixtieth day, defecation occurred normally *in amnio*. Not only did the fetus defecate into the sac but it subsequently reswallowed the thorium impregnated meconium and repeated the process several times. An examination of the films revealed that as the amniotic fluid was absorbed in the intestines the thorium remained behind in a dense mass and the sac gradually became very clear. When defecation occurred, a pool of the opaque material accumulated in the sac near the fetal anus and plaques of thorium could be found adhering once more to the sides of the sac. As this material mixed again with fresh amniotic fluid, the sac became cloudy and opaque. Reswallowing was marked by the reappearance of a stomach shadow. In specimens whose progress we were able to watch for any length of time, the entire cycle of swallowing, defecation and meconiophagy was repeated as many as five times before birth occurred. In Table I we have indicated by plus signs the number of times defecation and reswallowing occurred in any fetus.

We have thought it best to illustrate fetal swallowing, intestinal peristalsis, defecation, and meconiophagy in 10 selected films from a single fetus (pig No. 21). We were able to follow this animal for a period of 27 days and to observe its normal birth. During that time the fetus engaged in all of these activities. Evidence equally as convincing was found in the roentgenograms of each of the fetuses listed in Table I, although not in every instance was it possible to observe the entire sequence of events. Figures 1 to 10 show the course of a small quantity (0.6 c.cm.) of colloidal thorium hydroxide through the gastro-intestinal tract of this one fetus.

The fetuses ranging in age from 60 to 68 days may be divided into 2 groups. In one the mothers were subjected to anoxemia; in the other, they were untreated. Table III shows a comparison of these two groups in order to examine the experimentally produced effects of anoxemia upon the rate of swallowing the entire contents of the sac and upon the rate of passage through the gastro-intestinal canal. It appeared that under conditions of anoxemia the fetus swallows amniotic fluid faster than normally, the sac emptying in 13 hours as compared to a normal rate of about 23 hours. On the other hand, the rate of passage of material to the stomach, small intestine, and large intestine seems to be a little, though perhaps not significantly, slower in the case of the fetuses subjected to anoxemia. Of course, the number of observations upon which this table is based is rather small and the time intervals are at the best only approximate.

ANALYSIS OF RESULTS

It would seem from these experiments that swallowing of amniotic fluid begins normally around the forty-second day in the fetal guinea pig. In specimens between 35 and 40 days old, swallowing has not been observed. The injection material remains in the amniotic sac of fetuses this young until at least the forty-second day before it is swallowed. Why swallowing begins at this time and does not occur earlier, especially when Yanase (21) found that peristalsis is possible on the twenty-sixth

Fig. 9. The same pig, sixty-fifth day. Reconcentration of thorium hydroxide in the intestines. The amniotic sac is nearly clear again.

Fig. 10. The same pig, seventy-second day (day of birth). This demonstrates, especially well, defecation taking place *in amnio*. The arrow shows a pool of meconium.

or twenty-seventh day in the guinea pig, is a matter of conjecture at present. Certainly Yanase's data tell us little about what actually takes place in the normal fetus *in utero* and because he studied freshly killed material he looked upon intestinal motility under conditions of extreme asphyxia. It is even possible in fetuses as small as his that he mistook the writhing movements occurring near death (19) for true peristaltic movements.

On the other hand, it is interesting to speculate upon this question of the advent of swallowing *in amnio*. Perhaps we may look upon it as the beginning of an important nutritional function in fetal life, at least from the standpoint of water balance. As Reynolds has shown in the rabbit, partly from an analysis of Hammond's data, the volume of fetal fluids reaches a peak at about the twenty-fourth day of fetal life and then drops off rapidly until birth on the thirty-second day. At the time the curve for fetal fluids begins to drop precipitously, the fetal growth curve is rising rapidly. Concurrently, placental growth rate and efficiency are on the decline. Such a picture suggests that the fetus begins to take some of the water it needs for metabolism from the amniotic fluid at this point, and that as it grows it draws more and more upon this source, perhaps continuing to swallow the fluid almost as fast as it is formed until birth. A similar condition is encountered in the chick where Vrbitch found that swallowing begins about the tenth day of incubation. At present we do not have adequate data in the guinea pig to allow us to draw accurate comparisons with the rabbit. This much is certain from the fetal growth curves of the guinea pig presented by Draper and Ibsen: fetal growth is increasing rapidly about the forty-fifth day of prenatal life which is about the time we find swallowing. Both of these investigators have attempted to study the growth curve for amniotic fluid. Draper's data show an increasing quantity up to the forty-fifth day, after which the free fluid is variable but in many instances

TABLE I.—SUMMARY OF ALL DATA

Guinea pig no.	Age of fetus at injection	Thorium in stomach		Thorium in small intestine	Thorium in large intestine	Hours required to swallow all thorium	Defecation	Reswallowing	No. films taken	No. days followed
		Age in days	Hours after injection	Hours after injection	Hours after injection					
†34	39	43	96	119	192	—	—	—	9	8
‡8	41	42	24	265	—	—	—	—	15	17
12	43	44	21	—	—	—	—	—	2	2
16	43	44	22	69	165	118	+++	+++	18	16
21	46	47	19	46	68	105	+++++	++++	30	27
1	51	51	5	46	70	94	+++	++	13	12
15(A)	52	53	24	—	—	58	—	—	4	3
24	52	53	24	—	—	—	+	+	4	3
14	57	57	§ 4	4	47	47	+	+	10	8
‡ 8	59	59	½	§48	55	48	+++	++	14	12
18	59	59	7	60	—	—	—	—	5	4
10	60	60	1¼	20	—	—	—	—	4	2
27	60	60	2	25	—	31	—	—	3	2
8b	61	62	§26	§26	26	26	+	+	4	4
*17(A)	61	62	26	30	—	—	—	—	5	3
17(A)	61	62	26	46	—	—	—	—	5	3
*30	61	61	1	1½	19	18	—	—	5	2
30	61	61	?	?	24	18	—	—	5	2
36(A)	61	61	½	3½	24	§24	+	+	7	3
28(A)	62	62	½	§ 2	2	6	+	+	6	2
13(A)	63	63	½	—	—	—	—	—	4	1
20(A)	63	63	1¼	§18	18	—	—	—	4	2
22	63	64	§21	21	§42	§42	—	—	4	2
29(A)	63	63	3½	§22	22	24	++	++	9	4
32(A)	63	63	§ 1¼	1¼	18	—	+	—	7	6
14b	64	65	§17	§17	17	17	+	—	3	3
*22a(A)	64	64	2	5½	24	—	+	+	6	2
22a(A)	64	64	5½	§24	30	—	—	—	6	2
22a(A)	64	64	13¾	—	—	—	—	—	6	2
*24a	66	66	2½	20	22	—	—	—	6	2
24a	66	66	2½	20	22	—	—	—	6	2
24a	67	67	½	—	—	—	—	—	1	1
†34	68	68	§ ½	½	17	—	—	—	3	2

*Two or three fetuses injected in pigs Nos. 17, 30, 22a, and 24a.
†Pig No. 34—Reinjected same fetus on sixty-eighth day.
‡Pig No. 8—Reinjected same fetus on fifty-ninth day.
§Before.

strikingly diminished. More information is needed on this point, however. We also need to know more about the conditions of fluid exchange in the placenta during this period of fetal development.

It would appear from the present results that between the fortieth day of gestation and birth there is a marked increase in the efficiency of the fetal gastro-intestinal tract. The ability to propagate its contents improves rapidly from the fortieth to the fiftieth day. From then on improvement is more gradual until birth. With better intestinal propagation, there is an increase in the rate at which amniotic fluid is being utilized if we may judge from the concomitant increase in rate of

TABLE II.—EFFECT OF AGE UPON TIME REQUIRED TO SWALLOW ENTIRE CONTENTS OF AMNIOTIC SAC AND FOR THE THORIUM TO REACH STOMACH AND SMALL AND LARGE INTESTINE.*

Age range in days	No. of cases	Average time in hours to swallow contents of sac	No. of cases	Average time in hours for thorium to reach stomach	No. of cases	Average time in hours to reach small intestine	No. of cases	Average time in hours to reach large intestine
39 to 46	3	105.6	5	36.4	4	127.2	3	141.6
50 to 59	5	63.6	6	10.7	3	37.3	3	57.3
60 to 68	8	18.0	15	1.8 to 3.3**	12	16.4	13	21.9

*This table includes only those cases wherein there is little doubt about the time relationships involved.
**Including one atypical experiment in which 26 hours were required.

TABLE III.—POSSIBLE EFFECT OF ANOXEMIA UPON RATE OF SWALLOWING THE ENTIRE SAC CONTENTS AND UPON RATE OF PASSAGE THROUGH GASTRO-INTESTINAL TRACT.*

Age range in days	No. of cases	Average time in hours to swallow contents of sac	No. of cases	Average time in hours to reach stomach	No. of cases	Average time in hours to reach small intestine	No. of cases	Average time in hours to reach large intestine
Untreated 60 to 68	4	23	6	1.62	7	15.4	7	21.0
Anoxemia 61 to 64	4	13	8	1.92	5	17.3	6	22.7

*This table includes only those cases wherein there is little doubt about the time relationships involved.

swallowing amniotic contents. This is occurring at a time when the fetus is growing most rapidly.

Not all the results produced by experimental anoxemia are conclusive because the analysis has been based on few cases. However, it appears that swallowing of fluid is enhanced. Other fetal activities, and especially rhythmical movements, are increased in the early stages of anoxemia (18). It should be noted also that only under such conditions did aspiration into the fetal lungs occur (17). On the other hand our data merely suggest that intestinal motility is diminished after anoxemia. Windle and Bishop (19) found a general fall in smooth muscle tonus and peristaltic activity in cat fetuses when the placental exchange was interrupted and asphyxia set up.

It should be kept in mind that no anesthesia was used in this present study, laparotomies were avoided, and in all but a few cases an equal volume of amniotic fluid was withdrawn from the sac before the colloidal thorium, itself physiologically almost inert, was injected. Since no more than 1 cubic centimeter of thorium was introduced at any time, normal pressure was not markedly altered even in those few specimens from which no fluid was withdrawn. Therefore, we believe that the results obtained represent the true behavior of the fetal gastro-intestinal tract of the guinea pig *in amnio*. DeSnoo has already pointed to the practical significance of the technique employed in this study from the therapeutic standpoint.

CONCLUSIONS

1. Under normal physiological conditions *in utero*, the guinea pig fetus begins to swallow amniotic fluid about the forty-second day of gestation. This fact is indicated by the presence of a stomach shadow in roentgenograms after the amniotic sac has been injected with 0.4 to 1.0 cubic centimeter of colloidal thorium hydroxide or dioxide (thorad or thorotrast).

2. The rapidity with which the thorium reaches the fetal stomach after injection increases with age, taking about 36 hours in fetuses about 42 days old, and from 1.8 to 3 hours in fetuses near term (66 to 67 days).

3. The efficiency with which the material is propagated along the gastro-intestinal tract likewise increases with age.

4. The speed at which all the thorium is flushed out of the amniotic sac and into the gastro-intestinal tract increases progressively with age.

5. Late in fetal life, usually not before the sixtieth day, defecation begins to occur *in amnio* as a normal phenomenon. Meconiophagy is also a normal physiological function of guinea pigs *in utero*. The cycle of swallowing, defecation, and reswallowing of the thorium impregnated meconium may be repeated several times before birth.

6. It has been suggested, but proof is lacking, that the swallowing of the amniotic fluid is important from the standpoint of prenatal water metabolism. It may be significant that swallowing begins when the fetus is just starting to grow at its most rapid rate. Comparison with conditions in the rabbit suggests the probability that at this point the efficiency of the fluid exchange from the placenta via the blood stream is declining and that the fetus makes use of its reserve of fluid in the amniotic sac.

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MALIGNANT CHANGES IN FIBRO-ADENOMA OF THE MAMMARY GLAND

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IT is unquestioned fact that the better results achieved more recently in surgery of the mammary gland have been due not only to a refinement of surgical technique but also to a sharpened pathological diagnostic acumen. Recognition and demonstration by the pathologist that a significant number of fibro-adenomas of the breast may undergo malignant change have contributed to the increasing number of satisfactory results obtained in the operative treatment of mammary cancer. Surgical intervention is many times more effective for those patients in whom the lesion is localized to the mammary gland than for those in whom it has involved the regional lymph nodes. Furthermore, it is well known that certain localized tumors which present physical signs suggestive of malignancy do not show the histological changes of the same, while, conversely, carcinoma and sarcoma occasionally arise in a pre-existing tumor without causing symptoms and signs indicative of such a transformation. It is in the latter group of cases that the pathologist plays an important rôle in that he must find and recognize such changes. However, all fibro-adenomas should be removed, not only to rule out actual malignancy, but to forestall malignant deviation.

Although fibro-adenomas are usually considered under the pathological grouping of connective tissue neoplasia of the breast, they always contain a decided amount of epithelium in their structure. The various types of fibro-epithelial neoplasms are:

1. Those having origin from the subepithelial tissue and giving rise to the intracanalicular variety.

2. Those arising as a localized neoplasia of the pericanalicular and periacinar connective tissue. The amount of epithelium in such tumors may be considerable.

3. A combination of the two preceding forms may exist.

4. Fetal fibro-adenoma, as described by Ewing, presents several structures of the fetal breast, "including very cellular connective tissue, alveoli without membrana propria, and imperfect differentiation between ducts and acini." The cellular overgrowth may be pronounced and suggest malignant deviation.

The word "cystadenoma," used to designate a fibro-adenoma which contains an intracystic papilloma as part of its structure, is a misleading term, for no reference is made to the fibro-adenomatous origin. The ducts may become obstructed, cyst formation may occur, and the ductal epithelium may undergo hyperplasia. Formation of papillomas and perhaps subsequent malignant change may also then occur.

The sudden enlargement of a previously existent fibro-adenoma must always be viewed with suspicion. Malignant deviation of such tumors may be in either of two directions since two types of tissue are fundamentally present. The occurrence of carcinoma in these tumors is somewhat rare, but the transformation of the connective tissue into sarcoma is more frequent. Both types of malignancy often promise an excellent result to proper surgical treatment, for the carcinoma or sarcoma may be confined to the adenofibroma giving it origin.

CARCINOMA IN ADENOFIBROMA

The frequency of adenofibroma undergoing carcinomatous change is unknown for (1) detailed reports are few in number; (2) it is quite difficult at times to differentiate histologically between benign and malignant

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From the Division of Surgery, the Mayo Clinic and the Mayo Foundation.

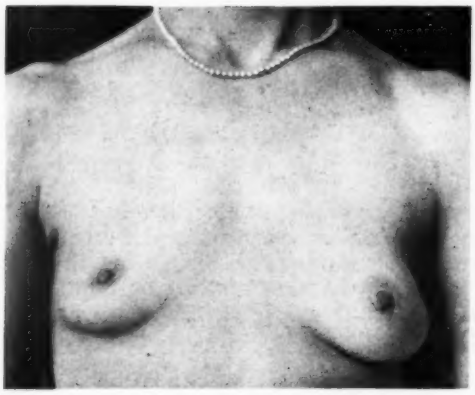

Fig. 1. Malignant lesion in left breast.

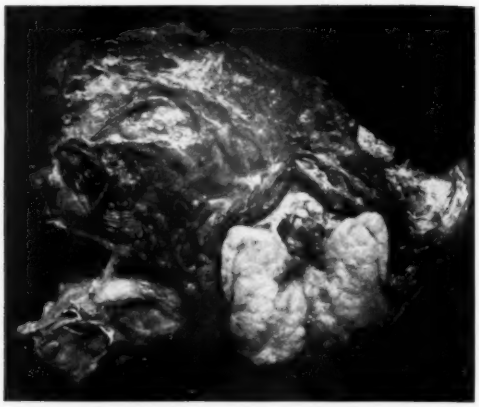

Fig. 2. Operative specimen.

tumors, and (3) a highly varied terminology is in use. In reviewing the literature 34 such lesions were found, and in addition, Ewing reported that he had encountered several moderately malignant carcinomas which appeared to have been derived from fibro-adenomas. The usual history reveals that a slowly growing neoplasm of fibro-epithelial structure had existed for some years and eventually grew much more rapidly with the onset of malignant changes. In such cases, the grade of malignancy has been moderate.

A review has been made of 15 patients having fibro-adenoma of the breast in which carcinomatous changes had taken place. The entire group is female. The youngest patient was 31 years old and the oldest 69; the average age was 46 years. Although the relationship between civil state and malignancy is unknown, all of the patients were or had been married. A family history of malignancy was obtained in but 3 cases. Practically an equal distribution as to the side affected was noted, the right mammary gland being involved eight times and the left, seven. In 6 of 10 patients from whom definite information could be obtained, it was learned that a tumor had been present in the breast previously for periods varying from 2 to 40 years, while 4 of this group stated that they had noted recent growth of the mass. A history of trauma to the breast was noted in but 1 case while 2 patients reported a loss of weight and 6 suffered from pain in the breast. The tumor was attached to the skin in 6 patients, and the nipple was retracted in 2.

The great majority of these neoplasms are of a low grade of malignancy. Upon a pathological basis of I to IV, 8 specimens were grade I, 4 grade II, 2 grade III, and in 1, consisting of 2 separate nodules in the same breast, grade II was present in one mass and grade III in the other. Involvement of an axillary lymph node by carcinoma was found only in the 2 lesions of grade III character.

Of these 15 patients, 1 has never been traced after her original dismissal. Eight of the group followed to the present are living and well. Five patients have died since operation but only 2 of these 5 had a recurrence. The remaining patient in this group, who had a grade I lesion, had been well for 9 years when last heard from. An analysis of these statistics reveals that 9 of this group have up to the time of their investigation lived for 5 or more years since operation.

Case 1. For emphasis and illustration, the history and clinical findings of one patient in this group will be detailed. A 37 year old white woman stated upon admission that she had noted a mass in her left breast for 3 years. For the past year it had been increasing in size. A history of trauma to or pain in the breast or of loss of weight was not obtained. Physical findings were essentially normal except for an irregular and fairly hard tumor, measuring 5 by 5 centimeters, which filled the left breast (Fig. 1). Some skin attachment seemed to be present and the

axillary lymph nodes were enlarged. The results of roentgenographic study of the chest were normal. Radical amputation of the left breast was done and examination of the specimen (Fig. 2) revealed a grade I adenocarcinoma in an intracanalicular fibro-adenoma (Fig. 3). The axillary lymph nodes were not involved. The patient had a smooth convalescence and has remained well subsequently.

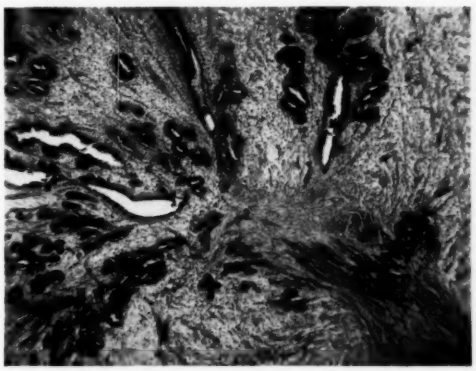

Fig. 3. Grade I adenocarcinoma in an intracanalicular fibro-adenoma. ×26.

SARCOMA IN ADENOFIBROMA

General recognition has been accorded the fact that a large number of sarcomas of the breast, perhaps more than has been generally realized, arise in pre-existing fibro-adenoma. Deaver and McFarland stated that in a total of 838 sarcomas, 193 were adenosarcoma, as they termed the mesodermal malignant lesions superimposed upon fibro-adenoma. Previously, S. W. Gross had reported that 33 per cent of 156 cases were "adenoid" in character.

This fact may be interestingly correlated with results obtained from animal experimentation. Heiman, in studying benign neoplasms of the breast of the rat, found that after 26 successive transplantations of a spontaneous fibro-adenoma, the tumor had suddenly become sarcomatous. Such an observation is also important in view of published reports of slowly growing human breast tumors suddenly changing their nature and assuming clinical and morphological attributes of a sarcoma. This fact and experiences such as that of Stark, in which after successive incomplete removals of an adenofibroma, the recurrences were progressively more cellular, may correspond in a degree to the changes effected in animal transplantation.

The enormous tumors of this category are those in which the epithelial elements have remained active, and in which dilatation of the ducts and acini has resulted in cystic formations of varying size. Usually, the history given by a patient with such a neoplasm is that a mass has been present in the breast for a long period, perhaps years, and that it suddenly has increased in size. Such neoplasms are irregular, nodular, and lobulated and are frequently complicated by hemorrhage, necrosis, and ulceration. From its initiation, the growth has a tendency to be somewhat circumscribed, and although it may become large, it still retains this characteristic. In addition, it may be freely movable upon the chest wall.

CASE 2. Many of these points are well illustrated by a 43 year old white, married woman who had noted a small mass in her left breast for 6 years. For 6 months before admission, the tumor had grown rapidly. Occasional sharp pain upon palpation was noted in the breast, but the patient had not noticed either bleeding from, or retraction of, the nipple. She had lost 20 pounds in weight in the 3 months before coming to the Mayo Clinic. The results of general physical examination were considered to be normal save for a large, nodular, irregular mass in her left breast. Although the neoplasm was attached to the skin, the latter was unbroken, the nipple was not retracted, and the growth was freely movable upon the deeper structures. Enlargement of the left axillary lymph nodes was thought to be present. Roentgenologically, the pulmonary fields were normal.

Pathological investigation, after operation, revealed a grade I adenofibrosarcoma with myxomatous change, arising on the basis of an intracanalicular adenomyxofibroma (Figs. 4 and 5). The patient has subsequently remained well.

When local removal is performed, recurrence is a marked feature. This may be due to an incomplete removal, for even in an apparently well circumscribed tumor, malignant cells frequently extend into the perivascular spaces beyond the capsule. In addition, malignant change may also take place in other fibro-adenomas of the same breast. Twelve recurrences were present in the case reported by Hoffman.

Many types of tissue may be found in such tumors. This wide diversity was realized

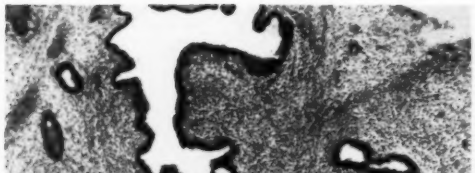

Fig. 4. Grade I adenofibrosarcoma with myxomatous change. ×33.

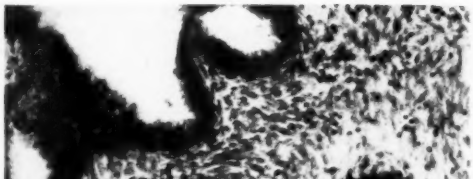

Fig. 5. Enlargement of area in section shown in Figure 4. ×155.

about a century ago by Sir Astley Cooper, for he stated then that all the changes which occur in other tissues may also be seen in the breast, and that in addition, it has some of its own. The presence of cartilage and bone has always been of interest, and, in 1937, Raso was able to collect 74 cases and add 1 of his own, in which these tissues were present. Historically, it is interesting to note that perhaps the first description of such a tumor was given by Morgagni.

CASE 3. An adenochondrofibrosarcoma was found in a 49 year old married, white woman who had noted a nodule in her right breast for 8 years before coming to the Mayo Clinic. The mass had grown slowly for 7 years and then it had begun to enlarge rapidly. Slight pain in the breast had been noted for 6 to 8 months, but of late it had been so severe that the organ had to be supported constantly. Ulceration of the breast or enlarged axillary or supraclavicular lymph nodes had not been noted by the patient. Cough and weight loss had not been present and she considered her general health good.

The results of physical examination were normal save for a slightly elevated blood pressure and a semifluctuant mass in the right breast. This was 20 to 25 centimeters in diameter and the overlying skin was tense, shiny, and discolored. The axillary lymph nodes were not enlarged and the results of roentgenographic examination of the chest were normal. Radical amputation was performed and the operative note was that the patient had a huge tumor involving the entire breast, the skin being glossy and inflamed. Marked edema of the lower half of the mammary gland was present and redness of the skin extended to the chest wall above. The microscopic report of the tissue examined was that a cystic degenerating grade II adenochondrofibrosarcoma that had developed on an intracanalicular fibromyxadenoma was present. The lymph nodes were uninvolved. The patient received a course of roentgen therapy after dismissal from the hospital and has since remained well.

Of the cases of adenofibrosarcoma encountered in this study (24) all but 1 were seen at the Mayo Clinic before operation had been performed on the breast. Of these 23 cases, which may be designated as a "primary" group, the following statements may be made. Twenty-two of the patients were women. Their ages ranged from 33 to 62 years, the average being 47 years. Five of these individuals reported that other members of their family had had malignant disease, and 14 of the group had noted that a tumor had been present in the mammary gland for periods varying from 2 to 31 years. Only one patient reported trauma to the affected breast and only 4 had lost weight. It is of some significance that 15 patients had experienced some type of pain in the affected breast, for pain is not usually present in the early stages of a malignant lesion. Interesting findings in the physical examination were a change in color in the overlying skin in 8, attachment of the tumor to the skin in 10, free mobility on the underlying structures in all. Clinically, the axillary lymph nodes were enlarged in 5 and the supraclavicular in 1. The thorax was normal in all patients subjected to x-ray study.

As in carcinoma arising from adenofibroma, the majority of the sarcomas were of low

pathological grade. Eleven were grade I; 8, grade II; 3, grade III; and but 1, grade IV. Several of these specimens contained tumor giant cells; this group comprised 3 of the grade II neoplasms, all 3 of the grade III, and 1 of the grade IV. Involvement of the axillary lymph nodes was not present in any of the cases.

Of the total of 23 patients, a complete follow-up was obtained in 17, and of the latter 10 are living and well. Of 7 patients definitely known to be dead, 4 died of unknown causes, 2 of unrelated conditions, and only 1 of a recurrence. Incomplete end-results were present in 3 patients and their present condition is unknown. Three of the patients have never been contacted since their postoperative dismissal.

The results of operation in this group as a whole have been favorable. We find that up to the time of investigation, 14 have lived at least 5 or more years. This favorable experience is in complete accord with the pathological grade of these lesions.

SUMMARY

Patients in whom malignant changes have occurred in adenofibroma have been studied. Of these, 15 had carcinoma while 24 had sarcoma.

It has again been demonstrated that adenofibroma does not always remain a benign fibro-epithelial tumor. If a mass is present in the breast and a presumptive diagnosis of "adenofibroma" has been made, it should be removed, if possible, to exclude plain malignancy or an adenofibroma in which malignant change has taken place.

Nine of the carcinomatous and 14 of the sarcomatous patients survived 5 years or more. These comparatively high figures are in complete accord with the low pathological grade of the lesions of both types.

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MANAGEMENT OF BREECH DELIVERY

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THE occurrence of breech presentation as a problem in the management of labor at term may be handled in one of three ways. The obstetrician may convert the breech to a vertex by the maneuver of external version; he may deliver the infant as a breech through the pelvis; or he may elect to perform cesarean section.

External version, when feasible, may be a very beneficial procedure. If successful, it converts a dangerous presentation to one which is distinctly less dangerous, thereby reducing the expected risk to the infant seven to tenfold. On the other hand it can never be expected to render breech delivery with its attendant problems and risks entirely obsolete, not only because the correct diagnosis of position is often not established until labor is advanced, but also because attempted version may either be unsuccessful or may, if successfully completed, be followed by a return of the fetus to its original position *in utero*. Consequently a discussion of breech delivery, whether through the pelvis or through the abdomen, can never be considered anachronistic.

Since the rationale of any method of treatment should be supported by the results obtained from its use, the management of breech delivery as here presented is based upon experience with the problem during 50 years in one institution, the Boston Lying-in Hospital. It is hoped that in the near future figures will be available for a survey of all breech deliveries in both house and out-patient service during the entire history of the institution. For the moment only a half century of hospital deliveries have been surveyed.

Figure 1 is a graphic representation of average fetal mortality occurring on the hospital service from 1888 through 1937. The white portions of the columns represent the figures for general fetal mortality regardless of presentation, position, or method of delivery; the whole columns represent the figures for mortality among breech-born infants. All deliveries are reflected, including abortions, miscarriages, stillbirths, and neonatal deaths from any cause whatsoever.

These gross figures must be modified considerably before the corrected mortality rate in breech delivery can be ascertained. In 1936, the writer published his standards for computing corrected fetal mortality (4), and called attention to the fact that until similar standards are used by investigators of this problem the comparison of results obtained in various clinics is of very limited value. For better or worse the standards recommended in 1936 will be used in this discussion.

When one thinks of the risk of breech delivery one usually considers it in relation to the obstetric hazards to which a normal living child presenting by the breech is subjected in the process of being born. This risk must be selected from the gross figures above reported before the rationale of management can be discussed intelligently.

Table I shows the process by which corrected figures are obtained. First of all, only cases uncomplicated by conditions which are dangerous or lethal to the infant are selected. "Complicated" cases, in which the gravid woman is afflicted with toxemia, eclampsia, nephritis, diabetes, cardiac disease, syphilis, hydramnios, and certain other pathological conditions, are excluded. One can hardly say that a stillbirth or neonatal death occurring in association with labor in an eclamptic, diabetic, or syphilitic woman is necessarily due to the factor of breech presentation alone, nor can one claim entire credit for the management of breech delivery in securing the birth of a live baby in such a case. The same thing is true when the process of gestation or labor is complicated by placenta previa or ablatio placentæ, since the actual delivery can neither take unqualified credit for a favorable outcome nor entire responsibility for

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Read at the New York Academy of Medicine, February 28, 1939.

stillbirth or neonatal death. In other words, such complicating conditions as have been mentioned require that the risk to the breech born infant of the woman suffering, for example, from eclampsia or placenta previa be compared only with the risk to any infant born under similar circumstances.

One complication of labor deserves especial consideration. In our series of mature breech deliveries, otherwise uncomplicated, frank prolapse of the cord occurred in 3.4 per cent of the cases. While it is true that, strictly speaking, the risk to the infant in the breech labor in which the cord prolapses should be compared with the risk to any other infant born following prolapse of the cord, the finding of a seven-fold greater frequency in our breech series than among deliveries at large indicates an appreciable increment of increased risk from this complication when the breech presents. Furthermore there is considerable evidence that occult prolapse or pressure on the cord intrapartum is present in numerous cases, as will be later discussed. For this reason, in Tables I and III the effect of prolapse of the cord upon the prognosis for the infant is shown in its influence upon the fatality rate.

The second and third categories to be excluded in computing the corrected mortality are those cases in which macerated or grossly malformed infants are delivered. The reason for this requires no explanation.

Limiting consideration, therefore, to the group of pregnancies and labors uncomplicated as previously defined, a final factor must be considered, that is, the weight of the delivered infant in relation to its gestational maturity. It is obviously inaccurate to point with pride to the successful outcome of the delivery of a premature infant weighing 1,500 grams or 3 pounds 5 ounces, and to count it as a favorable case in statistical computation if one is to exclude from the series the death from "prematurity" of another fetus of the same birth-weight. In this table, therefore, the premature infants, weighing less than 5 pounds, are segregated in one category, the immatures, weighing 5 pounds but less than 6, are placed in another. Our experience indicates that only 74.3 per cent of breech infants weigh 6 pounds or more; 10.9 per cent 5 to 6 pounds; and 14.7 per cent less than 5 pounds (4). Since the prognosis for the premature or immature infant is compounded of the weight at birth, the method of delivery, the anesthetic used, if any, and the postnatal care, no attempt will be made at this juncture to discuss these two categories; our corrected figures deal only with mature infants weighing 6 pounds or over at birth.

TABLE I.—DELIVERIES OF BREECH PRESENTATIONS AT THE BOSTON LYING-IN HOSPITAL FROM 1888 THROUGH 1937

	Cases	Deliveries	Well	Stillborn or died	Mortality per cent
A. Breech deliveries	2,035				
1. Uncomplicated	1,459				
a. Premature		221	99	122	55.2
b. Immature		178	162	16	8.9
c. Mature		1060	963	97	9.1
d. Mature, including 37 cases with frank prolapse of cord		1097	988	109	9.9
2. Complicated—including all cases with frank prolapse of cord	453				
3. Non-viable—macerated and malformed	123				
B. Cesarean sections	58				
1. Uncomplicated		52	49	3	5.7
2. Complicated	6				

Having in this fashion limited the problem to the management of the patient at or near term with a primary breech presentation, the next points to be considered are:

1. Is abdominal delivery indicated? If so, why?

2. What should the management of the case be if pelvic delivery is decided upon?

While routine cesarean section is frequently used for primiparous breech delivery, especially by surgically and non-obstetrically trained consultants, this procedure is radical, to say the least. Newell, in 1931, stated, "If the breech is not in the pelvis at the beginning of labor, and if the baby is unusually large, or if the pelvis is contracted, cesarean section may be properly considered, but the indication is not so much the breech presentation as the other factors in the case,

TABLE II.—INDICATIONS FOR CESAREAN SECTION IN BREECH DELIVERY

Primiparas		Multiparas	
1. Ankylosis, left hip	1	1. One or more previous stillbirths or neonatal deaths following pelvic delivery	7
2. Cephalopelvic disproportion, estimated by clinical and x-ray measurements	7	2. One or more previous cesarean sections	10
3. Elderly primiparity (37, 38, 41, 42, 43, 44)	6	3. "Small conjugate" plus previous craniotomy for hydrocephalic breech	1
4. Estimated large infant (all over 9 pounds)	4	4. Obstructing dermoid cyst	1
5. Pelvis, contracted	11	5. Antepartum hemorrhage in woman aged 44	1
6. Rupture of membranes, longstanding, without labor	2		20
7. Tuberculosis, active	1		
	32		
All mothers well. One infant died eleventh day of erysipelas.		All mothers well. One infant died of hydrocephalus, one of impetigo on the twenth-fifth day.	

such as disproportion between the child and the pelvis, early rupture of the membranes, and unsatisfactory dilatation of the cervix. In multiparas cesarean section is practically never indicated for breech presentations *per se* in the absence of other indications."

It would be a pleasure, if it were possible, to be able to state that the problem of fetopelvic disproportion could be reduced to a mathematical formula. We have long been accustomed to measure maternal pelves by means of calipers and by digital exploration, and have succeeded in identifying a few of them as being so contracted in one diameter or another as to render the birth of a living child through the natural passages quite impossible. The vast majority, fortunately, are large enough to allow spontaneous delivery, as attested both by measurement and by clinical experience. There remain, none the less, a group of cases in which the pelvis is of the borderline type, in which a test of labor may be resorted to before section is decided upon. This procedure, valuable as it is when we are dealing with vertex presentations, is of little value when the breech presents, because the aftercoming head has no chance to become molded by the forces of labor. There is no opportunity for a second guess after the head has come into relationship with the maternal pelvis, for if the original judgment has been faulty the infant is sure to be stillborn or fatally traumatized.

The work of Caldwell and his associates, at Sloane, and that of Thoms, at New Haven, have given us a changing concept of the architecture of the female pelvis and its effect upon the mechanisms of labor and of pelvic delivery. They have directed attention to the midpelvic planes, and are able, by somewhat different methods of approach, to quantitate the diameters of the pelvis at its various levels. Most of their published work, however, deals, logically enough, with the problem of vertex labor in association with the various types of pelves which they have described. One important point is still unanswered: Can x-ray studies predict the ability of the aftercoming head to pass through the maternal pelvis?

Herein lies the crux of the problems of cephalopelvic relationship in breech presentation. The ideal mathematical formula would answer this by indicating that the infant's head, unmolded, would pass through the pelvic inlet, the interspinous plane, and the pelvic outlet. Before this can be derived some method of measurement of the infant's head, preferably of the essential biparietal diameter, must be available.

In the autumn of 1931 the task of measuring by x-ray the heads of breech infants *in utero* was undertaken by the writer in conjunction with Dr. Stewart H. Clifford, who was interested in the problem of determining the occipitofrontal diameter in relation to the maturity of the infant and eventually to the predictable birth weight. The crossed-wire or crossed-thread technique of stereoroentgenometry was used, and the measurements recorded were compared with the caliper measurements of the infant's heads at birth. Clifford's series, which was much larger than the breech series due to the enormously greater incidence of vertex presentations, yielded results which were much more encouraging for his purposes than did the smaller number of measurements of the head in the fundus. The latter showed that an

accurately measurable diameter of the head could be demonstrated in 65 per cent of the cases investigated by x-rays, whereas the balance were unmeasurable; taking, however, the measurable cases as a group, 89 per cent of them yielded a satisfactory occipitofrontal silhouette, 8 per cent a biparietal shadow, and 3 per cent an oblique plane from which neither the occipitofrontal nor the biparietal diameter could be read or calculated.

These findings, while of value, are nevertheless at best an approximation. Summarized in another way they indicate that there is only a 5 per cent chance by this method of securing the important biparietal reading direct at the first observation, and a 58 per cent chance of measuring the occipitofrontal diameter, from which the biparietal diameter can be predicted only within certain limits. It is undoubtedly more accurate than the mere laying on of hands but falls far short of the ideal quantitative method.

Finally, the method of stereoroentgenometry shows the weakness of all stereoscopic observations, namely, the personal equation. Stereoscopy is essentially qualitative rather than quantitative and is only of value to the individual who possesses binocular vision. Stereoroentgenometry is not a method susceptible of being recorded for all to see, as are the x-ray measurements of Thoms; its interpretation, either by projections into space by crossed-threads or by the precision stereoscope, is subject to the personal equation of the observer.

Table II summarizes the cesarean sections done for uncomplicated breech presentation at the Boston Lying-in Hospital. The first section in a multipara with this condition was done in 1899, the first in a primipara in 1911. The table shows that among 32 primiparous sections, 18, or over half, were done for varying degrees of estimated fetopelvic disproportion; 6, or almost one-fifth, for elderly primiparity; and 4, or one-eighth, for presumably large infants. All the mothers survived. One infant died on the eleventh day postpartum of erysipelas. The two commonest indications for section in the 20 multiparous cases were either one or more previous sections, or previous catastrophes in connection with pelvic delivery. All of these mothers survived. Two infants were lost, one from impetigo on the twenty-fifth day, and one from hydrocephalus; had the mother been roentgenographed before section in this case and in one other in the series in which a hydrocephalic child was born, it is likely that the 2 cases would not have been subjected to abdominal delivery.

TABLE III.—MORTALITY IN BREECH DELIVERY, MATURE INFANTS, BEFORE AND AFTER MARCH 1, 1921

	Deliveries	Well	Stillborn and died	Intercurrent	Mechanical	Mortality per cent
Single pregnancies						
1888—March 1, 1921	387	330	57	11	46	14.7
March 1, 1921—1937	599	564	35	7	28	5.8
	986	894	92	18	74	9.3
Single and multiple pregnancies						
1888—March 1, 1921	427	366	61	12	49	14.3
*March 1, 1921–1937	633	597	36	7	29	5.6
	1060	963	97	19	78	9.1
*Additional mortality when cases of frank prolapse of the cord are added.						
1888—March 1, 1921	448	381	67	14	53	14.9
March 1, 1921–1937	649	607	42	8	34	6.4
	1097	988	109	22	87	9.9

Since there were 500 mature primiparous breech deliveries through the pelvis during these 50 years, as against 32 cesareans, abdominal delivery was resorted to in 6 per cent of the primiparas. Among the 500 pelvic deliveries 5 infants lost their lives because of misjudgment of fetopelvic relationship. This experience seems to indicate that 7 per cent of primiparous breeches at term should be delivered by section. Adding the 20 multiparous breech cesarean sections to the 560 multiparous pelvic deliveries the incidence of abdominal delivery was 3.4 per cent. Since 6 infants among 560 were lost by reason of disproportion the incidence of section might better have been 4.6 per cent.

As regards pelvic delivery of the breech infant, it may well be admitted that the nature of the presentation and the mechanism of labor are such as to enhance the risks of birth to an appreciable degree. In our clinic from

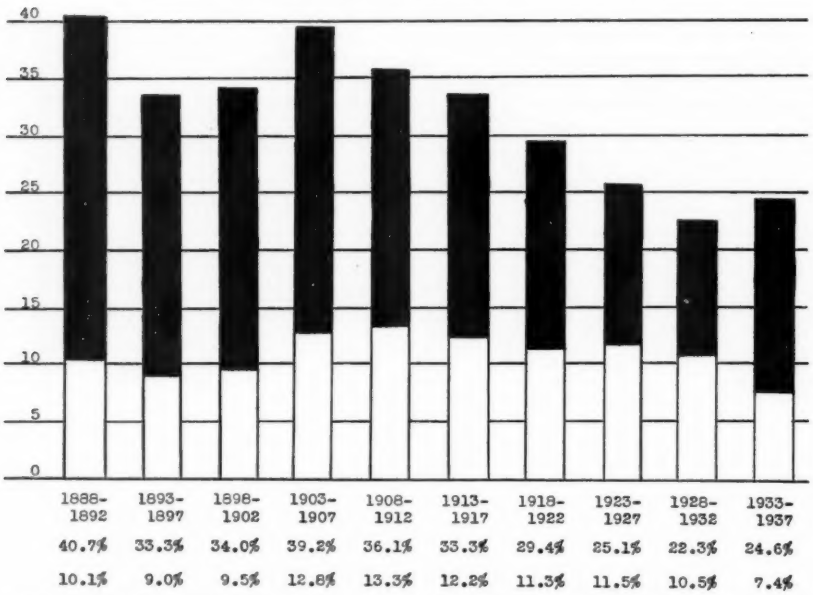

Fig. 1. Gross fetal mortality in all deliveries (white segments) contrasted with gross fetal mortality in breech deliveries (whole columns).

1913 to 1935 it was shown that the corrected mortality rate for mature breech born infants was 6.9 per cent, as contrasted with a corrected mortality rate on the service at large of 0.7 per cent, indicating a tenfold risk from the presentation *per se* (4).

It is generally taught that the conduct of labor when the breech presents should be conservative. The patient should be kept in bed during the first stage in order to prevent, if possible, early rupture of the membranes. During the second stage the accoucheur should be scrubbed and prepared to assist delivery if delay should occur after the infant is born to the umbilicus, otherwise only if the condition of mother or infant should render interference imperative.

Some clinicians do not agree with this method of management. DeNormandie, writing in 1914, gives a hint of this when he states: "The author believes that all breech cases at the final expulsive stage should be under complete anesthesia. . . . I have too often seen physicians try to deliver the arms and after-coming head in cases without ether and then hurriedly and cruelly clap on the ether cone expecting to obtain in a few seconds complete relaxation. No one knows when an arm will be extended, and never can the best intelligent suprapubic pressure be given with the patient straining at the utmost with her abdominal muscles." In 1926 Irving and Goethals advocated elimination of the second stage in breech delivery by extraction at full dilatation. Piper and Bachman in 1929 and Dorsett in 1932 have advocated essentially the same procedure. Schwartz, 1932, states that complete and footling breeches should be delivered at complete dilatation, whereas frank breeches are allowed to deliver spontaneously if continuous progress occurs.

These authorities are cited as evidence of an appreciable minority who believe that certain dangers to the fetus in conservative breech delivery may be avoided by a more active policy. These are, briefly, the risk of compression of the cord during the second stage of labor, a risk which should be ascertainable if constant watch of the fetal heart is kept; the risk of sudden intrapartum separation of

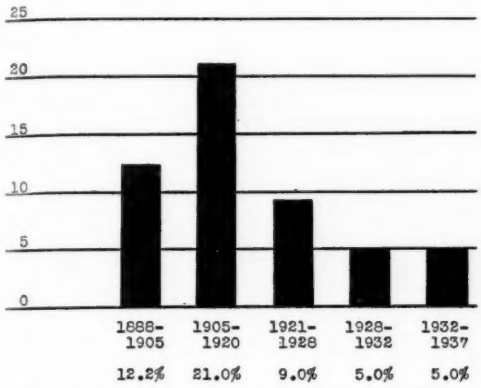

Fig. 2. Mortality in primiparous breech delivery of 482 mature single infants, 1888 to 1937.

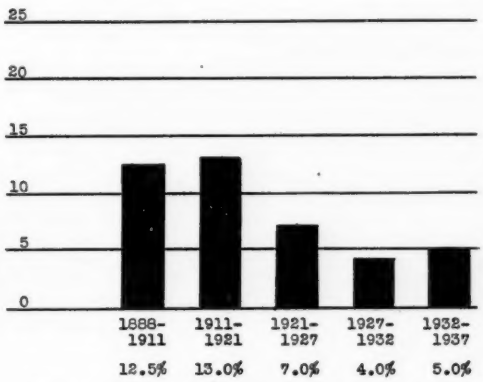

Fig. 3. Mortality in multiparous breech delivery of 504 mature single infants, 1888 to 1937.

the placenta during the second stage; and the dangers of hurried completion of the extraction should progress be delayed by difficulty with shoulders or head after appearance of the umbilicus at the vulva.

We believe that the fetus *in utero* presenting by the breech is essentially a truncated cone, with the smaller end passing first. Certainly this is true of the footling breech, the circumference of which, non-inclusive of the legs, has been stated by von Jaschke as 24 centimeters. The aftercoming head has an average suboccipitofrontal circumference of 34 centimeters according to Williams. Consequently, complete dilatation of the os uteri is seldom if ever encompassed by the dilating action of the breech itself; hence the frequency with which extended arms occur, and the common necessity for applying forceps to the aftercoming head. For this reason we believe that the policy of allowing the breech to crown and the body to be delivered to the umbilicus by the expulsive efforts of the patient herself, aided or not by suprafundic pressure, is no guarantee against these mechanical hazards. On the contrary we believe that a methodical deliberate extraction under full surgical anesthesia after the breech has passed the cervix does not in any way predispose to dystocia of shoulders or head, but actually makes its occurrence less to be feared than under the classical method of management.

The figures of corrected mortality in breech delivery presented in Table III are identical with those in Table I, save that they are arranged for the purposes of this discussion in a somewhat different way. On March 1, 1921, Irving and Goethals undertook as a special assignment on the hospital service to extract all breeches during the second stage. This policy has, in general, been carried on to the present time, although the concept of elimination of the second stage of labor requires some modification. Nelson and Eades, in 1935, found that despite efforts to obviate the second stage in the delivery of cardiac patients 64 per cent of the multiparas investigated by them and 14.1 per cent of the primiparas delivered themselves normally. The second stage of multiparous labor may be very rapid, and even in primiparas the exact moment at which full dilatation occurs is often not determined. A better statement of our policy is to say that extraction is undertaken after, but not necessarily immediately after, attainment of full dilatation with respect to the breech.

The figures indicate that the stillbirth and neonatal death rate has been reduced by more than 50 per cent since the above policy was started. While it is quite likely that other factors, such as increased interest in and watchfulness over the breech labor, may be involved, the fact remains that the figures are all derived from the same institution over

TABLE IV.—SUMMARY OF 78 STILLBIRTHS AND NEONATAL DEATHS FROM MECHANICAL CAUSES

	Cases
Group A. Mechanically easy delivery of apparently normal infants, with neonatal death occurring a few hours to several days later, with evidences of intracranial hemorrhage	14
Group B. Mechanically easy delivery, with stillbirth, or birth of child in manifestly poor condition who cannot be revived or who dies shortly thereafter	24
Group C. Mechanically difficult or traumatic delivery	40

a period of 50 consecutive years, and that the improvement in results, as shown in Figures 2 (6) and 3 (7), has continued down to the present time. A second special assignment of breech deliveries included in these figures was undertaken by the writer from October 1, 1931, to April 1, 1933, during which period 83 infants were delivered, with 2 neonatal deaths, accounting for a mortality rate of 2.3 per cent (5). Save for this the breech deliveries have been routinely handled by the resident and house staffs from March 1, 1922, to the present.

The stillbirths and neonatal deaths in this series are classified as *mechanical* and *intercurrent*, according to causation. Mechanical deaths are those due to asphyxia or trauma, demonstrable clinically or at postmortem. Intercurrent deaths result either from incidental pathology of early neonatal life presumably independent of the birth process, or from such purely extraneous circumstances as intrauterine death during labor before admission to the hospital. Nineteen of the 97 fatalities accounted for in this series are so classified.

Study of the 78 mechanical fatalities in this series shows that they occur in one of three ways, as arranged in Table IV.

Group A. Mechanically easy delivery of apparently normal infants, with neonatal death occurring a few hours to several days later with evidences of intracranial hemorrhage. This group may be likened to similar deaths following normal vertex or cesarean delivery.

Group B. Mechanically easy delivery, with stillbirth, or birth of a child in manifestly poor condition who cannot be revived or who dies shortly thereafter.

Group C. Mechanically difficult or traumatic delivery.

TABLE V.—SUMMARY OF DELIVERY IN 24 GROUP B FATALITIES

	Cases
1. Prolonged second stage of labor with rising or irregular fetal heart	3
2. Sudden loss of fetal heart after admission to hospital, and from 21 minutes to 2½ hours before delivery	3
3. Stillbirth occurring in association with normal breech delivery	3
4. "Assisted" breech delivery, with stillbirth or birth of a child asphyxiated and dying 30 minutes to 3d day postpartum	5
5. Intrapartum bleeding followed by rising fetal heart	2
6. Easy extraction at full dilatation: baby stillborn or died 1 to 7 hours after birth	5
7. Easy extraction. Baby breathed when head reached perineum, but could not be resuscitated	1
8. Easy extraction after dilatation of early contraction ring	1
9. Easy extraction after prolapse of foot at 4 to 5 fingers' dilatation and sudden loss of fetal heart	1
	24

The two groups of the greatest interest are B and C. Of the 40 fatalities in the last named group, 27, or 67.5 per cent, occurred in the era of conservatism, that is, before 1921. On the other hand it is only fair to add that 16 of the 27 were delivered through cervices which either had not reached full dilatation or which required manual dilatation before extraction was carried out. Since 1921, 7 of the 13 group C fatalities occurred following extraction through a cervix which had been incompletely prepared. The effect of this factor upon the mortality rate is tragically apparent.

The 24 fatalities in group B are analyzed in Table V. Study of their records indicate that in 13, or over half, *something* happened during the second stage, quite possibly an occult involvement of the cord. This assumption, in view of the frequency of frank prolapse, does not seem unreasonable. At all events the evidence suggests that if extraction had been done earlier some, at least, of these 13 dead infants would have survived.

SUMMARY AND CONCLUSIONS

1. The management of breech presentation has been discussed, based upon the corrected statistics obtained from a study of 2,035 pelvic breech deliveries and 58 abdominal cesarean sections in the Boston Lying-in Hospital from 1888 to 1937 inclusive.

2. About 7 per cent of primigravidas with breech presentations at term should be delivered by section.

3. Roentgenographic mensuration of the fetal head *in utero* has a definite if limited value in helping to diagnose fetopelvic disproportion. The ideal method of making a comparison of the fetopelvic relationship in breech presentation has not yet been determined.

4. The statistics and experience derived in this study indicate that, if delivery through the pelvis is selected as the method of choice, the second stage of labor should be terminated by breech extraction under full surgical anesthesia before the birth of the umbilicus, as has been classically recommended, has occurred.

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ANOXIA AND OXYGEN THERAPY IN HEAD INJURY

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THE recognition and prompt treatment of conditions due to severe oxygen deficiency is a matter of past history. The vicious circles resulting from mild oxygen want are slowly being recognized. Following concussion of the brain, with or without skull fracture, varying degrees of anoxia might be expected to occur on the basis of shock (stagnant anoxia), alterations of respiration due to injury of the respiratory center (anoxic anoxia), neurogenic hyperthermia due to disturbance of the temperature regulating center (relative anoxia due to increased oxygen demand by the tissues), decreased circulation through the brain due to increased intracranial pressure, vasodilatation, edema, and hemorrhage.

The absence of any report in the literature together with the importance of mild anoxia prompted this investigation of anoxia and oxygen therapy upon dogs and patients with head injury. Oxygen had been used at the Henry Ford Hospital in the treatment of patients with cerebral hemorrhage and with head injury upon the suggestion of F. W. Hartman at the time these studies were undertaken.

METHODS

The first part of this investigation was performed upon 9 normal dogs by one of us (J. G. S.). Samples of blood were drawn anaerobically from the femoral artery of the unanesthetized dogs and analyzed for oxygen content, oxygen capacity, and oxygen saturation according to the method of Van Slyke and Neill. Under light chloroform anesthesia (1 to 2 minutes) concussion of the brain was then produced by a blow on the head. In order to ascertain the effect of the chloroform, dogs 1 to 3, were permitted to recover from the anesthetic and arterial blood samples were obtained 1 hour later. These dogs were then re-anesthetized and brain concussion was produced. Femoral artery blood samples were again taken 2 to 3 hours later and in 4 dogs, 8 to 24 hours later. Aseptic cisternal puncture was performed upon each dog at the time that the first blood samples following cerebral concussion were drawn, and the cerebrospinal fluid pressure and the presence of blood were noted. Oxygen was administered by nasal catheter to 6 of the 9 dogs for from 1 to 2 hours, and blood samples were again taken. Oxygen flow through the catheter was maintained at 8 to 10 liters per minute. According to Barker, Parker, and Wassell this produces an alveolar concentration of 50 to 55 per cent oxygen.

Blood samples were obtained anaerobically from the femoral arteries of 12 patients with recent head injury at the time of their admission. Routine observations of body temperature, pulse, respiration, and blood pressure were also made. Skull fracture was looked for in the x-ray films. Six of the patients were placed in oxygen tents and additional blood samples were obtained 24 to 36 hours later.

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RESULTS

The arterial blood oxygen saturation varied from 91.9 to 94.2 per cent in the 9 normal unanesthetized dogs (Table I). Light chloroform anesthesia (1 to 2 minutes) did not affect the arterial blood oxygen saturation. Blood samples taken from dogs 1, 2, and 3, one hour after recovery from the anesthetic showed normal saturation values of 92.2, 92.5, and 91.9 per cent, respectively. Two to 3 hours following the experimental concussion of the brain, oxygen saturation was depressed from 9.3 to 37.4 per cent below normal in 8 of the 9 dogs. All of these dogs were unconscious. Cisternal puncture showed blood to be present in the cerebrospinal fluid in 8 of the 9 dogs, and the pressure was elevated from 30 to 58 millimeters of cerebrospinal fluid pressure in 7 of the 9 dogs and was normal in 2. No depression of blood oxygen saturation

TABLE I.—ARTERIAL BLOOD OXYGEN IN DOGS FOLLOWING CONCUSSION OF THE BRAIN

Dog	Femoral artery blood oxygen saturation				Cerebrospinal fluid (2–3 hours after injury)	
	Normal per cent	Brain concussion				
		2–3 hrs. per cent	O_2 1–2 hrs.* per cent	8–24 hrs. per cent	Pressure	Blood
1	91.9	78.1	92.8		146	2+
2	92.8	57.3	85.6		178	3+
3	92.4	60.7		70.3	132	2+
4	93.2	79.5		87.4	165	1+
5	92.9	95.4		92.8	96	0
6	92.8	81.4	90.4		156	1+
7	94.2	83.9	92.9	85.7	170	2+
8	93.0	52.6	78.0		100	3+
9	92.6	83.3	90.6		122	2+

*Nasal oxygen 8 to 10 liters per minute.
Saturation at the end of therapy.

was found in dog 5. This dog was unconscious for only about 2 minutes and showed no changes in the cerebrospinal fluid. Its blood oxygen saturation was elevated 2.5 per cent 3 hours later because of hyperpnea. Six of the dogs (Nos. 1, 2, 6, 7, 8, and 9) were given oxygen for 1 or 2 hours at the end of which the oxygen saturation of the blood was determined. The oxygen saturation was elevated in all; it was raised to 90 per cent or above in four, from 57 to 85 per cent in dog 2, and from 52 to 78 per cent in dog 8. These results on dogs with a head injury show that the oxygen saturation of the arterial blood may be decreased by head injury and that it can be elevated by oxygen therapy.

Gas analysis of blood from the femoral arteries of 12 patients with recent concussion of the brain (6 with skull fracture) showed the oxygen saturation to be normal in 2 patients (about 90 per cent), depressed 6 to 10 per cent in 7, 11 per cent in 1, and 34 per cent and 44 per cent in each of the other 2 patients (Table II). Body temperature elevations varied from 0 to 3.4 degrees F. while the pulse rate and blood pressure were fairly normal in all except patients 4 and 5, who showed signs of shock with a slightly lowered blood pressure and an increased pulse rate. The first 6 patients were not treated with oxygen. Patients 1, 4, and 5 showed the greatest

TABLE II.—ANOXEMIA IN PATIENTS WITH HEAD INJURY

Patient	Time	Femoral artery blood oxygen saturation per cent	Temperature	Pulse	Respiration	Blood pressure	Skull fracture
1	Admission	81.8 D	101.0	60	25	110/60	+
2	Admission	86.6	99.0	90	20	120/80	0
3	Admission	94.0	98.8	90	36	120/60	0
4	Admission	48.2 D	98.6	136	24	90/40	+
5	Admission	58.4 D	100.2	112	28	100/80	+
6	Admission	89.9	98.0	84	18	104/64	0
7	Admission	86.7	102.0	62	20	156/50	0
	O_2 24 hrs.	93.3	100.4	58	20	135/70	
	30 days	94.5	98.6	60	20	—	
8	Admission	84.8	98.4	98	20	120/80	0
	O_2 24 hrs.	90.8	98.8	86	18	120/80	
9	Admission	86.5	100.8	76	20	134/83	+
	O_2 36 hrs.*	93.1	100.0	66	20	120/68	
		91.2	98.2	78	20	118/70	
10	Admission	85.7	99.2	80	20	130/84	+
	O_2 24 hrs.*	89.6	99.6	80	20	126/76	
11	Admission	86.6	102.4	110	20	90/60	0
	O_2 24 hrs.*	92.4	98.0	72	18	110/70	
12	Admission	84.6	98.8	86	20	126/80	+
	O_2 24 hrs.*	93.2	99.0	80	18	120/80	

*Oxygen tent.
D Died.

depression of oxygen saturation in this group of patients, and died. The remainder of the patients in this series lived. Patients 3 and 6 showed normal blood oxygen saturation values. The high saturation (94 per cent) in patient 3 was associated with a respiratory rate of 36. Patients 7 to 12, all of whom received oxygen therapy, showed a moderate depression of blood oxygen saturation (6 to 10 per cent) upon admission and an early elevation of body temperature. After 24 hours in the oxygen tent, the blood oxygen saturation was restored to and above normal, and the body temperature was depressed in all except patient 8 (0.5 degrees F. rise).

Although the oxygen therapy reduced the fever and restlessness in some of the patients and although there appeared to be some clinical improvement, opinions regarding the therapeutic efficacy of the oxygen must

be reserved until a large series of patients is observed.

EVALUATION OF STUDY

It is not surprising that injury to the brain, which is the site of the respiratory and circulatory centers, results in a depression of blood oxygen saturation below normal. Without prompt treatment, cases of severe anoxia offer a grave prognosis while conditions of mild oxygen deficiency may set up vicious circles. Schnedorf has shown experimentally in dogs that the mild degree of trauma associated with the slow aseptic withdrawal and immediate replacement of 6 to 8 cubic centimeters of cerebrospinal fluid caused marked elevations of intracranial pressure (124 to 156 mm.), an increase in cerebrospinal fluid protein (122 mgm. per cent), cells (1,546), and body temperature (3.9 to 4.2 degrees F.) above normal while the arterial blood oxygen saturation was depressed 10 to 15 per cent below the normal level. Similar withdrawal and replacement of cerebrospinal fluid in another series of dogs, in which the blood oxygen saturation was maintained at or above normal by the administration of nasal oxygen, decreased the severity of these reactions. In this group, the cerebrospinal fluid pressure rose only 63 to 69 millimeters, proteins were 53 milligrams per cent, and the number of cells in the cerebrospinal fluid was only 672. Elevation of body temperature did not occur. This work shows that moderate anoxemia is responsible in part for the increased permeability of the cerebral vascular system and the subsequent increased intracranial pressure, edema of the brain, and the presence of blood, by diapedesis, in the cerebrospinal fluid.

The experiments on dogs show that cerebral concussion causes a depression of arterial blood oxygen saturation below normal and also that the administration of oxygen may increase the oxygen saturation. This increase in the oxygen saturation of the blood occurred within 1 to 2 hours after the institution of oxygen therapy. One to 2 minutes of light chloroform anesthesia employed in this study on the dogs had no delayed effect upon blood oxygen saturation. Dogs 1 to 3 recovered from the anesthesia within 3 minutes and showed normal arterial blood oxygen saturation 1 hour later. In most of the human cases of head injury observed in this study, the depression of blood oxygen was mild (5 to 10 per cent), causing only a mild oxygen deficiency; however, in some cases the depression was as much as 34 to 44 per cent. The elevation of body temperature seen in so many patients with head injury (neurogenic hyperthermia) produces a marked increase in tissue metabolism and an increased demand for oxygen. In these patients the oxygen deficiency therefore may be greater than the level of blood oxygen unsaturation would indicate. Traumatic shock, when associated with head injury results in a lowered blood pressure and produces anoxia of the stagnant type. The question of sedative medication in these patients is an important one. From his statistical study, Schreiber feels that anoxemia caused by analgesics and prolonged labor causes damage to the brain and is responsible to a large extent for the apnea, morbidity, and mortality of the newborn. Morphine, paraldehyde, and the various barbiturates not only cause a depression of blood oxygen saturation but also have a direct depressant effect upon the utilization of oxygen by the brain tissues as demonstrated *in vivo* and *in vitro* by McClure, Hartman, Schnedorf, and Schelling and *in vitro* by Jowett, and by Hundhausen. For this reason, heavy sedation with these drugs should be avoided.

In view of these experimental facts, it is obvious that mild anoxia can be and should be promptly treated. The anoxia can harm the patient whereas oxygen administered properly can only benefit the patient.

CONCLUSIONS

1. The presence of mild as well as severe anoxia should be recognized as an important factor in the morbidity and mortality of head injury with cerebral injury.

2. Brain concussion, with or without skull fracture, caused a depression of arterial blood oxygen from 5 to 44 per cent below normal in dogs and patients.

3. Oxygen therapy restored the blood oxygen saturation to and above normal and

decreased the marked elevations of body temperature to normal. In dogs this occurred in from 1 to 2 hours.

4. The presence of fever makes the oxygen deficiency of the tissues relatively greater than the level of the unsaturation of the arterial blood would indicate.

5. Sedative medication, which causes a further depression of blood oxygen saturation and also a direct depression of the utilization of oxygen by the tissue cells, should be avoided as much as possible.

6. Oxygen therapy is indicated for the combatting of the anoxia which result from head injury and for the amelioration of reactions which follow brain injury and mild anoxia.

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A CONSIDERATION OF SO CALLED "GRANULOSA" AND "THECA" CELL TUMORS OF THE OVARY

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THE Society of Gynecological Pathologists of New York has collected a group of 61 ovarian tumors[1] which have been diagnosed as belonging to the group of neoplasms having their origin in the theca granulosa cell complex. The authors were appointed to study these tumors as well as the clinical data of the patients from whom they originated. The work is as yet incomplete; however, the material was found to yield information justifying a partial report at this time.

As the scope of this paper must be limited, no attempt will be made to summarize the literature or to present completely the various points of view concerning etiology, the life cycle or cellular relationships of these tumors. It will not be amiss, however, to call the attention of those interested in an exhaustive presentation of the subject, to two monographs which have appeared in recent months: *Les Tumeurs de la Granulosa* by J. Varangot, and *Granulosatumoren* by W. Schiller, will repay careful reading. We shall consider only those features of the neoplasms which have not been clearly understood and are therefore somewhat controversial.

Despite the very extensive literature that has developed as the result of the study of the tumors since von Kahlden described the first case in 1895, there is still a great deal of confusion concerning their morphological variations, as well as their hormone producing potentialities. The monograph by Varangot illustrates some of the errors that have crept in. In all, 274 so called granulosa cell tumors have been studied and reported. In 1932, Loeffler and Priesel described what they considered to be a distinct type of tumor of ovarian origin, and named it "fibroma thecocellulare xanthomatodes ovarii." Of this peculiar type of variation of the graafian-follicle-like neoplasms, 22 have been studied and reported. Recently doubt has been expressed as to the validity of the attempt to classify this group of tumors as being separate and distinct from the better known and more frequently seen granulosa cell group, for it has been suspected that pure tumors of the two cell types were rare and a number of tumors have been reported in which there existed obvious mixtures of both cells. The title of this paper reflects the caution into which the minds of the authors have been placed as a result of their study of a large group of tumors of the so called granulosa type.

Of the 61 tumors offered for study, 7 were excluded because it seemed dubious that they were composed of theca or granulosa cells. As all the tumor material had been fixed previous to this study, it was not possible to conduct hormonal studies upon it, and therefore evidence of hormonal activity has been adduced from the clinical history of uterine bleeding or amenorrhea as substantiated by the microscopic appearance of the endometrium. The tissues were studied by a variety of staining methods. In addition to the common tissue stains, Masson's polychrome, and Foot's silver stain were found of most help in differentiating not only the cellular variations but also that which has proved of equal importance, the relation of the various cells to the reticular elements of the supporting connective tissue framework. The Hoerr-Romeis fat stain was utilized in the studies of differential lipoid content.

The general organization of the tumors is interesting and helpful, as a correct inter-

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[1]The tumor material collected by the Society came from the Bellevue Hospital, Beth Israel Hospital, Margaret Hague Maternity Hospital, Memorial Hospital, New York Hospital, Roosevelt Hospital, Sloane Hospital, Woman's Hospital.

pretation of structure gives a clue to the potentialities and life history of the tumor. The survey of the collection of tumors demonstrated that the classification suggested by Robert Meyer is reasonably adequate and useful, as it serves as a means of description of the tumors. This classification provides three main groups: the folliculoid, the cylindroid or trabecular, and the sarcomatoid.

Before going further in a description of the different classes of the tumors, we present a statement of the criteria and the means of differentiating between the two main types of cells, that is, theca and granulosa cells. As has been amply testified by the students of the graafian follicle and the corpus luteum, accurate differentiation between these two types of cells is never easy and is sometimes impossible. However, comparatively little work has been done with the aid of silver impregnation methods, and so far as we are aware, the Foot silver stain has never been used in connection with theca and granulosa neoplasms. This technique has many advantages. It not only reveals the argentifine characteristics of reticulum and cellular cytoplasm, but it also gives a finely graduated tonal differentiation of all the cells. It is distinctly superior to the Da Fano and Cajal methods with which it has been compared in this study. The following description of the differences between theca and granulosa cells is based upon our studies with the Foot silver stain.

Neoplastic granulosa cells occur in islands consisting of from a few to several hundred cells. They seldom exist singly. The islands are surrounded by strands or networks of reticulum carrying with them numerous theca cells and the vascular supply.

The nuclei of theca and granulosa cells are impossible to distinguish from one another, as they contain similar nucleolar and chromatin bodies. However, the cytoplasm of the granulosa cell contains many argentofile granules, whereas the cytoplasm of the theca cell is almost devoid of these bodies. In addition, the theca cell is always in intimate relationship to the reticular framework to such a degree that each cell is surrounded by a capsule of this material which isolates it from its neighboring theca cells. In contrast, the granulosa cells exist in groups, usually of large numbers, each cell being in immediate contact with its neighboring granulosa cells. The complete island of granulosa cells is surrounded but not penetrated by the reticulum.

The application of these differential points makes it possible to analyze the graafian follicle tumors as to their content of these two types of cells. It is not claimed that the method is completely satisfactory in all tumors, as there were a number of instances in which we were left in serious doubt; however, it is felt that it affords a new approach to the study of this group of tumors, which will yield data not formerly obtainable. The descriptions of the theca cells as given is presented with the knowledge that others, namely, von Werdt, Davanzo, TeLinde, Kauffmann, and Robert Meyer have considered the possible presence of theca cells in tumors of "granulosal nature" but have concluded that they were demonstrable only in small numbers, if at all.

The folliculoid type of tumor is one that most definitely tends to produce the tissue to which it is related, and structurally, more or less completely simulates the graafian follicle. These represent the most differentiated type of the tumor and always contain not only granulosa cells lining the follicles, but also numerous theca cells filling the interstices of the supporting connective tissue of the lamina propria. In other words, these are true follicular tumors and are mixed in the sense that they contain both theca and granulosa cells. Approximately 20 per cent of our tumors fall into this category. They all produced large quantities of hormone, as judged by the history of uterine bleeding and the finding of hyperplastic endometrial tissue. None of our folliculoid group had malignant characteristics either clinically or histologically.

A much larger group than the foregoing is composed of tumors in which the potentialities for differentiation are less marked. That is, they are composed of large groups of cells growing in sheets, or round or oval islands. This type of tumor has been called "cylindroid" by Robert Meyer, which term does as well as any other, but lacks the inclusive descriptive characteristics which one who

studies the tumors soon learns to desire. The configuration of the islands of cells is determined first by the fundamental fact that they do not possess the ability to differentiate into follicles, and second by the relationship which the connective tissue bears to the immature tumor and then tends to modify as the tumor becomes older. The granulosa cells are accompanied, as in the folliculoid type of tumor, by a supporting reticulum in which one finds many theca cells. As the theca cells have a shorter life cycle in the sense that they become luteinized and undergo collagenous degeneration earlier than the granulosa cells, the sheets of granulosa become divided in various patterns to form the columns of cells suggested by the term "cylindroma"; but just as often, the division involves a much finer pattern with the formation of connecting lattices of fibrous tissue so that the strands of granulosa cells give a watermarked silk or trabecular effect.

If one examines a *young* tumor of this variety, which has been stained to demonstrate not only the theca and granulosa cells, but also the reticulum, one will find that it has no well defined cellular arrangement, but is composed of a conglomerate mixture of both granulosa and theca cells, the former tending to be arranged in very small groups which are surrounded by extensive irregular areas in which reticulum supporting and containing theca cells predominates. Several such tumors have been reported and correctly interpreted, the most recent one having been described by Greenhill. As the young tumor matures, the theca cells undergo collagenous degeneration and this material, together with the reticulum, serves to divide the granulosa into various patterns depending upon its extent and deployment, on the one hand, and the multiplication of the granulosa cells, on the other. The cylindroid or trabecular type of tumor represents about 44 per cent of the material of this study. They always produced estrone in our series, and hence, hyperplasia of the endometrium, during the phase of maturity of the granulosa cells; however, when these cells are few in number, or immature, as well as after they have undergone a considerable degree of luteinization and subsequent degeneration, they may produce such small amounts of hormone as to actuate no hormonal phenomena which can be determined clinically. Luteinization in small degree is exceedingly common in this type of neoplasm. Major degrees of luteinization are rare; however, one of our tumors measuring 12 by 15 by 16 centimeters had almost completely undergone this lipoid change. Two of the eight instances of malignancy occurred in the cylindroid type of tumor.

The third general type of tumor has been called the undifferentiated or "sarcomatoid" group. About 26 per cent of our tumors fall into this classification. It is in the sarcomatoid group that pathologists quite naturally make the greatest number of diagnostic errors, inasmuch as the clinical and histological characteristics are prone to wide variation. In this group the cells maintain growth in uninterrupted sheets until maturity or until various types of degeneration disrupt them. The theca cells and the reticulum are usually found, but to a lesser degree than in the foregoing types. As would be expected, the incidence of malignancy is highest in this group and the life cycle of the tumor seems to be a shorter one than in the other subdivisions. Degeneration due to hematoma formation, ischemia, and senescence, is more common. Very often these tumors do not produce enough hormone to make their presence evident clinically. When they survive for any considerable time, they undergo extensive fibrosis so that one finds huge areas of hyalinized and fibrous connective tissue surrounding comparatively small islands of granulosa cells. In the extensively fibrosed state, one may find no surviving theca cells.

To the foregoing classification we would like to present two other categories, namely, the *pure granulosa cell* tumor and the *pure theca cell tumor*. This is done with many reservations, as it seems rather unlikely that there can be many tumors which, if subjected to sufficient scrutiny, will qualify as members of either of these two groups. However, with the material available, the authors have been forced to classify 4 of the 54 tumors as pure theca cell tumors, and 1 as a pure granulosa cell tumor. It would seem almost certain,

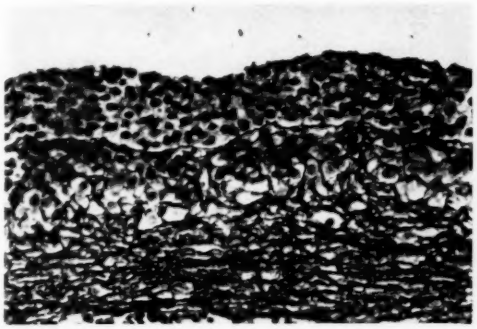

Fig. 1. Margin of normal graafian follicle showing relationship of reticulum to theca and granulosa cells. The reticulum forms a network about each theca cell and also a definite line of demarcation between theca and granulosa layers.

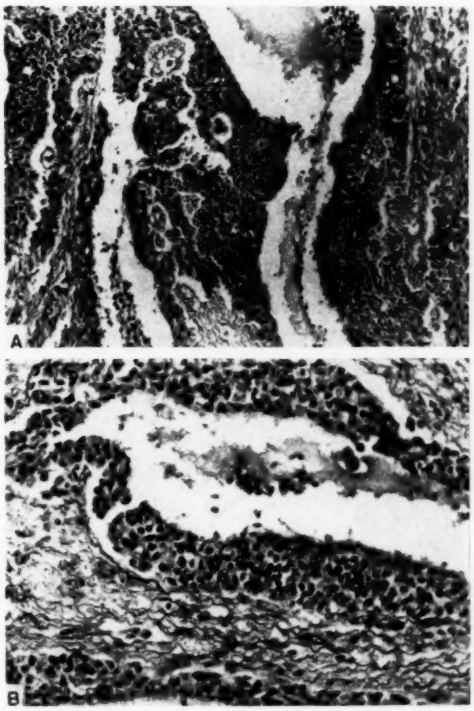

Fig. 2. Follicular type of graafian follicle tumor (Foot's silver stain). a, Low power shows granulosa lining the acini and tongues of reticular connective tissue in the lamina propria. b, High power of same tumor shows the marked differentiation of granulosa and theca elements, the latter being embedded in a reticular network similar to that seen in the normal follicle.

from what is known of graafian follicle tumors, that if each tumor could be examined at various stages in its growth instead of just at one, there would be times when both of the cortical layers of the follicle would be represented in the neoplasm. The pure granulosa cell tumor of our collection is poor in connective tissue, the columns of granulosa cells being supported largely by the blood vessels and a meager connective tissue. At the center of each group of cells, there is apt to be found a Call-Exner body, although this is by no means constant. There is a small number of cells which have undergone luteinization, indicating that it is not an immature tumor. Mitotic figures are not seen. It is a variation of the graafian follicle tumors, which from all available criteria is well stabilized. It produced a marked hyperplasia of the endometrium which was associated with profuse uterine bleeding.

The four pure theca cell tumors are almost identical with one another in structure. They are composed of a very extensive and dense framework of reticular fibers. Each theca cell is enveloped in a capsule of reticulum. Many of them are luteinized and there are large areas of collagenous degeneration. No islands of granulosa cells can be found. There are no mitotic figures; indeed, the whole picture is one of markedly quiescent growth, suggesting a very cellular fibroma of the ovary. Many readers will doubtless at once credit these four "pure theca cell" tumors to the category of ovarian fibromas. The authors have carefully considered the validity of this conclusion and have decided that the tumors certainly are not ordinary ovarian fibromas, but have every appearance of being theca cell tumors. Moreover, they give the characteristic sudan staining reaction with the Hoerr-Romeis method. Doubtless, some ovarian fibromas are associated not only with theca cell tumors, but in our opinion, may be the results of degeneration of small tumors containing many granulosa cells.

Most interestingly, none of these tumors produced any appreciable hormone. If these be truly theca cell tumors, and we feel that they are, then this finding is most suggestive

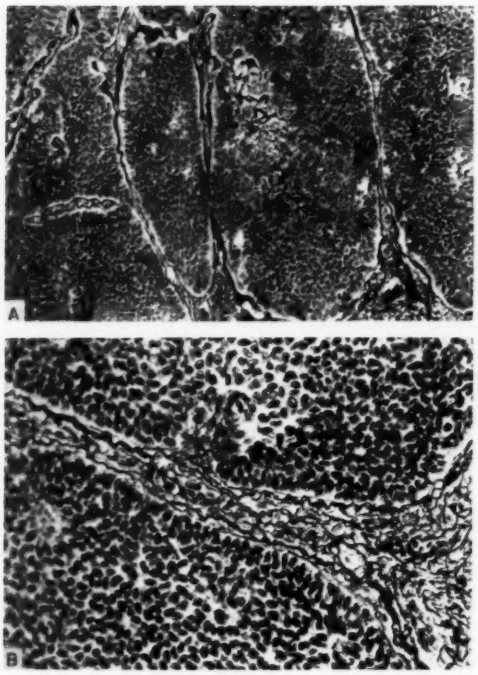

Fig. 3. Cylindromatous type of graafian follicle tumor (Foot's silver stain). a, Low power shows general topography of the tumor. The large islands of granulosa have a very moderate reticular framework surrounding them. Here and there, a few theca cells can be discerned in the reticular net. This tumor is predominately granulosal, with only a moderate representation of the theca cells. b, High power shows reticular border between two granulosal islands in which theca elements are strikingly demonstrated.

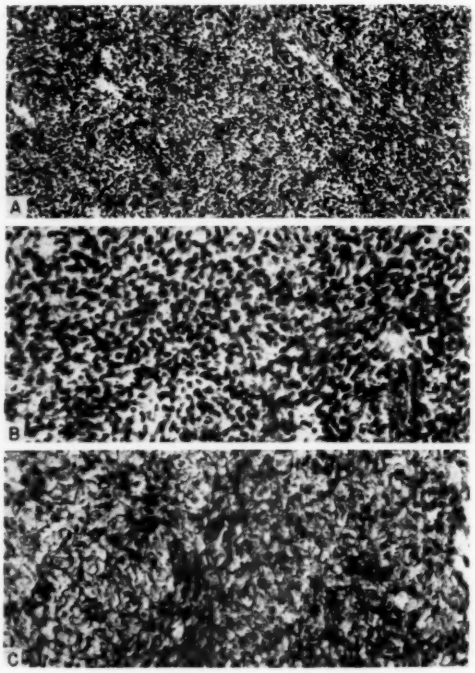

Fig. 4. Sarcomatoid Type of graafian follicle tumor (Foot's silver stain). a, Low power shows a very fine diffuse type of reticular framework common in immature or undifferentiated tumors. With this magnification, it is impossible to differentiate the two types of cells which make up the tumor. Actually, theca cells constitute about one-half the cell mass, while granulosa forms the other half. b, High power, center, shows an area of the tumor in which granulosa predominates, but on the right of the picture thecal elements are recognizable. c, High power, at bottom, from another portion of the same tumor showing almost pure theca cell growth with only a few granulosa cells discernible.

of the possibility that the theca cell does not produce an estrogenic hormone, or at least does not secrete estrone as has been generally supposed. From these observations it would seem probable that most of the theca cell tumors reported in the literature as having been associated with evidence of estrone activity might be explained by the possibility that they were not pure tumors of theca cells but contained fairly large numbers of granulosa cells as well.

It is not suggested that the theca cell never secretes estrone, as that conclusion is not justified from the observation of only 4 pure theca cell tumors. Conclusive evidence can come only as the result of the study of many tumors in various stages of development. As stated, our 4 tumors all gave evidence of *maturity* and of some senescence; it is therefore entirely possible that younger tumors may be capable of hormone production. However, additional evidence will be given later to show that the higher the content of theca cells is found to be in a given graafian follicle tumor, the less likely its association with evidence of hormone production.

ENDOCRINE ACTIVITY

Of the 54 graafian follicle tumors, 15 were found to afford no evidence of hormonal

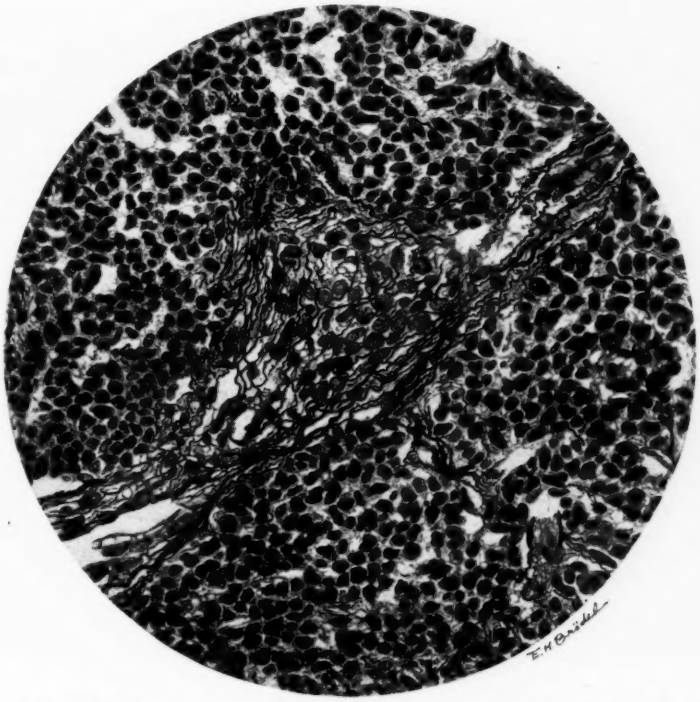

Fig. 5. The junction between three lobules of a cylindroid type of graafian follicle tumor is shown in the drawing. The septum of reticulum fibers contains many well-preserved theca cells. In other areas of the same tumor the granulosal growth of the lobules had compressed the intervening septa so that only a few theca elements survived. The relationship as shown may be observed in the great majority of so called "granulosa cell" tumors.

activity, either clinically in the form of excessive uterine bleeding, or histologically by the production of a hyperplastic endometrium. Our attention was called to them by the frequent notation in the history that the patients were suffering from amenorrhea. That 28 per cent of such a group should fail to present the generally accepted evidences of hormonal activity, demands an explanation. We have found that the tumors associated with amenorrhea have in common one or more of the 3 following characteristics: (1) they are relatively undifferentiated, belonging usually to the sarcomatoid group; or (2) they have a high theca cell content; or (3) they are markedly fibrosed or have undergone other forms of degeneration. The 4 pure theca cell tumors, of course, fall into this category, as all were associated with the lack of any form of excessive uterine bleeding or hyperplasia of the endometrium. In the undifferentiated cell group, 2 different conditions were found characteristic of the granulosa cells, which may be of importance, namely, they were either of the immature cell type and may have been abnormal for that reason, or they appeared to be postmature as evidenced by considerable areas of luteinization. Thirty-six tumors of the collection gave ample and unmistakable evidence of pronounced estrogenic activity. No information was available concerning the 3 others.

Two tumors of the series were associated not only with amenorrhea but with evidences of masculinization. The clinical picture of the 2 patients is almost identical. They exhibited

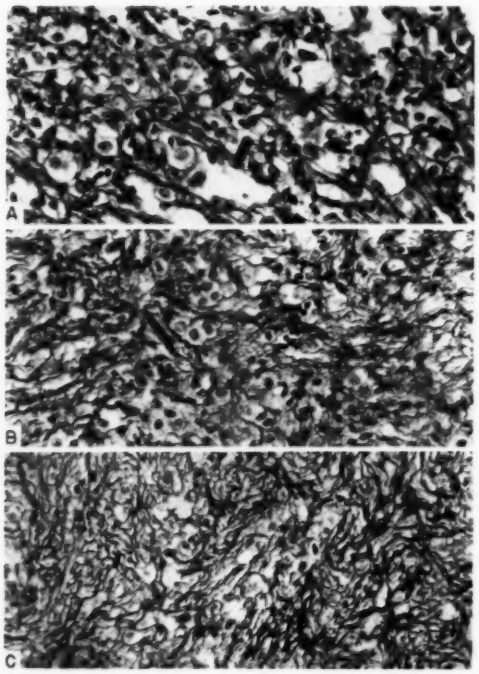

Fig. 6. Three graafian follicle tumors, showing the mixture of the two types of cells. a, Predominately thecal in nature, but many granulosa cells are demonstrable; b, Also composed mainly of theca cells, with only slight granulosa represented. c, Another example of the mixture of cells.

marked bodily hair growth with masculine distribution, deepening of vocal pitch, breast atrophy, hypertrophy of the clitoris, and amenorrhea. One of these tumors has a typical folliculoid arrangement and seems to be an undoubted granulosa cell tumor, while the other is of cylindroid type and, while it contains no areas that suggest the possibility of its being an undifferentiated arrhenoma, that possibility cannot be entirely ruled out. After the removal of the first tumor, the patient resumed normal menstruation, although she has not conceived to date. Unfortunately, the second patient died as a sequel to the operation, so that nothing can be known concerning her potentialities for resumption of normal endocrine functions. We are not in a position to elucidate these paradoxical exceptions to the usual feminine endocrine pattern which is associated with the graafian follicle tumors. Several other instances have been reported in the literature. Most of these instances have been associated with what have been described as luteinized tumors, which suggests the possibility that they may actually have been tumors arising from adrenal rests either in the vicinity of the ovary or actually incorporated in the organ. Examination of the tissues of the 2 cases which are here reported seems to preclude this possible explanation as applicable to these 2 instances.

AGE INCIDENCE

The usual teaching concerning the incidence of graafian follicle tumors has been that the granulosa type was most frequently seen in the postmenopausal period, whereas the theca cell type was more frequently observed during the reproductive period. This series of 54 tumors is distributed in a somewhat different age relationship. During the first decade of life, 1 tumor occurred; during the second, 2 tumors; the third, 3; the fourth, 12; the fifth, 19; the sixth, 9; and the seventh, 7. In other words, 69.81 per cent, or nearly 70 per cent, may be said to have occurred prior to or during the menopause (the average menopausal age in New York being 49+), and 30.19 per cent after its advent. The greatest incidence of the tumors was from the age of 30 to 50 years. Inasmuch as this roughly corresponds to the reproductive period, it was thought that it might be instructive to learn whether or not there was any relationship between parity and the incidence of the tumors. In the fourth decade, it was found that 8 of the 12 women were either nulliparæ or primiparæ. In the fifth decade, nulliparæ and primiparæ equally balanced the multiparæ. This is too small a series to evaluate such data, but it is suggested that parity may perhaps tend to reduce the incidence of the tumors.

AMENORRHEA, OR LACK OF UTERINE BLEEDING

Failure of the tumor to produce sufficient hormonal stimulation to cause hyperplasia of the endometrium followed by uterine bleeding

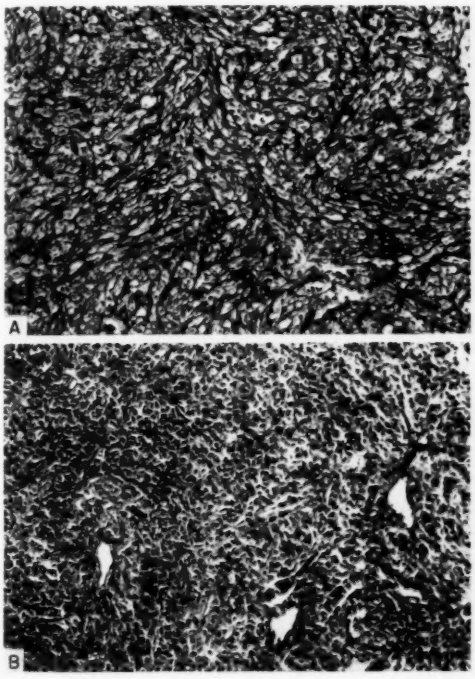

Fig. 7. a, Pure theca cell tumor with low magnification, showing the highly developed reticulum and cell content. b, Pure granulosa cell tumor is shown in contrast. Note the paucity of reticulum and complete lack of theca cells.

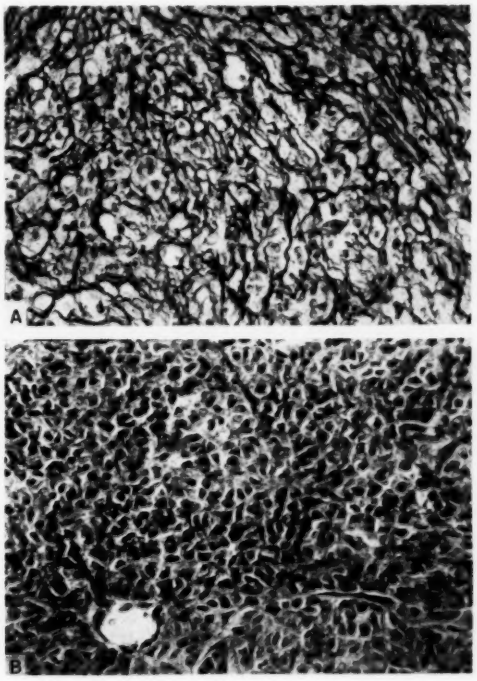

Fig. 8. High power photomicrographs of the two tumors which are represented in Figure 7. a, Theca cell tumor; b, granulosa cell tumor.

was characteristic of 15 of the patients of the series, an incidence of 28.3 per cent.

Uterine bleeding as a result of pronounced estrogenic activity, with or without hyperplasia of the endometrium, was present in all the remainder, with the exception of 3 patients concerning whom no data were available. Of those who failed to produce the symptom of uterine bleeding, all but 2 individuals were preclimacteric. These 2 patients were 50 and 55 years of age.

The tumors were unilateral in 44 of the patients, occurring with equal frequency upon the right and left. Six patients had bilateral tumors and no data were obtainable concerning 4 of the cases. Ascites was found on 7 occasions. In 2 of these the fluid was blood-tinged. Only 2 of the tumors associated with ascites proved to be malignant, and in each instance the fluid was a clear straw color. On one occasion, hydrothorax was a prominent feature of the patient's physical examination, and abdominal fluid was found at the time of operation. However, the tumor in the ovary proved to be quite benign.

SIZE

The largest tumor of the series measured 18 by 20 by 22 centimeters and occurred in a woman of 37 years. Two very small tumors were found, 1 measuring 5 by 7 millimeters, and the other 15 millimeters in diameter. No correlation could be found to exist between the age of the patient and the size of the tumor.

MALIGNANCY

Eight, or 15.4 per cent of the tumors, were clinically and histologically malignant. Of these patients, 5 died of the disease within a

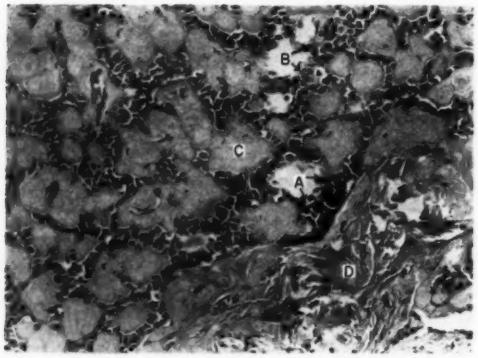

Fig. 9. Granulosa cell tumor. A very unusual granulosa cell tumor showing various stages in the life cycle of a neoplastic granulosa cell. *A*, Granulosa cell in various stages of maturity; *B*, lutein cells; *C*, areas of collagenous degeneration; *D*, fibrosis.

comparatively short time after its recognition, while another died of postoperative pneumonia. Of 2 of the patients, nothing is known. Only 1 patient has survived for 4 years and is apparently quite well. She received postoperative deep x-ray therapy because of peritoneal and cul-de-sac metastases. Five other patients received deep x-ray therapy, 3 of them after operation, while 2 received both pre-operative and postoperative treatment of this type; all died within 14 months. It would seem, therefore, that in the malignant group of tumors, x-ray therapy is not effective in retarding or stopping the progress of the growth. The very short time interval passing between the treatment and the demise of the patient would seem to warrant this conclusion.

EFFECT OF INTRA-UTERINE RADIUM IRRADIATION

Inasmuch as radium is frequently used in the cavity of the uterus for the treatment of a variety of gynecological diseases, and particularly because it is known that radiation of the immature mouse's ovary can produce graafian follicle tumors, it is interesting to note what, if any, stimulating effect there may be in the ovary of the woman. In the material under study, there are just 2 instances that may throw some light upon this question. One patient received 1,200 milligram hours of radium irradiation, which was followed 20 months later by the removal of a benign granulosa cell type of tumor. The other patient received a much larger dosage, 3,600 milligram hours, which was also followed some months later, the exact time is not known, by the appearance of an ovarian tumor of the granulosa type which required removal. This tumor was also benign.

These data are insufficient to warrant conclusions. They do indicate, however, that radiation of this type does not prevent the appearance of the tumor and does not destroy it if it is already present.

THE LIFE CYCLE OF GRAAFIAN-FOLLICLE-LIKE TUMORS

The ultimate etiology of the human tumors is still in doubt, although Furth and Butterworth, Traut and Butterworth, and more recently, Geist, all working with the experimentally produced granulosa tumor of the mouse's ovary, have shown that in this animal the tumor does not arise from the celomic epithelium as has been taught formerly, but forms from elements of the connective tissue of the ovary. This evidence reinforces the thesis of Fischel and his school, who have maintained that the cellular elements of the graafian follicle are developed by differentiation of the mesodermic elements of the ovary. Meyer's hypothesis that differentiated mesoderm is produced in excess of that necessary to envelop the primordial ova and that, hence, cell nests of this cellular material remain in the ovary occasionally for long periods of time with subsequent development into a neoplasm, is still valid. The cell nests have been demonstrated and tumors of all dimensions are described in the literature. It is safe to say that no one, today, believes that the graafian follicle tumors originate from the differentiated follicle, the corpus luteum, or even the atretic follicle.

The stimulus which may cause the residual islands of embryonic cells to develop is not known; however, the greatest incidence of the tumors coincides with the period of greatest gonadotropic activity of the anterior lobe of the hypophysis, that is, during the reproductive period and the early years of the menopause. It may not require too great a

stretch of imagination to suppose that the stimulus which causes the normal cells of the graafian system to proliferate has a similar effect upon the residual embryonic cell nests causing them to assume neoplastic tendencies.

Whatever the growth stimulus may be, it is quite clear that it is not always present in uniform degree. The evidence for this conclusion lies in tumors which frequently show wide variation in the age of various portions of the same tumor. The result of periodic growth is that the neoplasm is frequently an aggregate of groups of cell masses produced at different times and having different degrees of maturity and senescence. The immature cells probably do not secrete hormone, and as the same is true of the senescent cells, it is evident that the composite effect of the tumor in the hormonal sense, at any given time, must represent the resultant activity of the groups of cell masses which have recently reached maturity. Therefore, the tumor cannot maintain an even level of hormone production, but must present wide fluctuations dependent upon the state of growth and nutrition, with the result that response in other organs must also fluctuate in an irregularly periodic manner. In addition, various collateral events may occur which tend to minimize the hormonal effectiveness of the tumor, such as ischemic necrosis and hematoma formation. The latter is very common in the folliculoid type of tumor. These facts explain quite satisfactorily why some women are amenorrheic at the time they come to the physician.

Most graafian follicle tumors produce symptoms which bring the patient to the physician, with the result that the great majority of tumors are removed before they have reached the end of their life cycle. It is, therefore, necessary to postulate what some of the terminal aspects of the neoplasms may be. However, we know that if the tumor is not adversely affected by such accidents as ischemia and hematoma formation, the cells tend to mature and to undergo quite typical degenerative changes. The theca cells reach the end of their life cycle sooner than do the granulosa cells. Luteinization occurs in both types of cells and this is followed by collagenous degeneration, which is replaced by fibrosis. The greater the content of theca cells, the more likely the tumor is to produce fibrous connective tissue. The granulosa elements, however, being poorly supplied with supporting framework upon which to dispose themselves, and being less intimately supplied with blood vessels, are more prone to premature accidents which interrupt the other forms of degeneration that might otherwise ensue.

SUMMARY

1. A study of 54 ovarian tumors of the theca granulosa cell group is reported.

2. The use of Foot's silver stain makes possible the differentiation of theca from granulosa cells in most instances.

3. So called granulosa cell tumors contain varying amounts of theca cell elements as well, so that pure granulosa cell tumors are rare. Most tumors contain from ¼ to ⅓ of their differentiated cells in the form of theca cells. A number of tumors were encountered which had equal representations of the two cell types, while most so called theca cell tumors also contained granulosa elements in considerable representation. One pure granulosa cell tumor and four pure theca cell tumors are described.

4. An attempt is made to outline the life cycle of these tumors and its relationship to the clinical syndrome they present.

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THE ANATOMY OF THE SUBPERITONEAL TISSUES AND LIGAMENTOUS STRUCTURES IN RELATION TO SURGERY OF THE FEMALE PELVIC VISCERA

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IN a previous article (Curtis, Anson, McVay, 1939) the anatomy of the pelvic and urogenital diaphragms was described anew, especially in relation to factors important in pelvic repair. Therein, attention was directed to the firm fascia which lines the muscular floor of the pelvis and is termed the superior fascia of the pelvic diaphragm; it was demonstrated that where the pelvic viscera pierce the pelvic floor the fascia is carried upward upon these hollow organs as tightly fitting investments or "collars," sometimes blending with, even becoming almost inseparable from, the outer muscular coat of each.

The present offering presents a continuation of our investigation, based on further observations in the operating room correlated with dissections of human material, substantiated by necropsy dissection of fresh specimens. A chief objective of this article is to discuss the relation of the endopelvic fascial collars to the ligamentous and cellular investing and supporting tissues at a higher level, chiefly in their relationship to the uterine supports and adjacent associated structures. The illustrations are from life-size drawings by Tom Jones made from successive dissections of a single carefully selected specimen.[1]

Although it is intended to integrate the anatomical details hereinafter described with those of the more inferior pelvic region previously considered, the regional anatomy may be most logically discussed in conjunction with the illustrations by considering the structures in the order in which they are encountered in pelvic dissection from within the abdomen, from above downward.

The commonly encountered descriptions of the pelvic organs are, in their general features, in accord with the observations made in the present investigation. Nonetheless, since knowledge of the form and relations of these viscera is fundamental to an understanding of the regional variations in the character of their serous and fibrous investments and their ligamentous supports, certain of these well recognized anatomical facts will be mentioned in the course of our description.

I. PERITONEUM

In the specimens studied, including the one presently to be described, the course of the peritoneum conforms to the descriptions presented in standard textbooks of gross anatomy.

From the internal surface of the anterior abdominal wall the peritoneum is conducted downward to the superior surface of the urinary bladder; only this superior surface is covered by peritoneum, the inferolateral and posterior surfaces being separated from the back of the pubic bone and the fascial covering of the obturator internus and levator ani muscles merely by a thin stratum of extraperitoneal connective tissue. From the superior surface of the bladder the peritoneum is next reflected to the anterior surface of the uterus, slightly above the level of the internal os of the cervix; from each lateral border of the uterus it is then carried, winglike, to the side wall of the pelvis, as the anterior leaf of the broad ligament. Continuing over the fundus of the uterus, the peritoneum descends upon the posterior surface of the uterine body and the posterior wall of the vagina to the level of the external os of the cervix; draped over the uterine tube at either border of the uterus, it passes downward as the posterior leaf of the broad ligament. Extending to the front of the rectum, the peritoneum is reflected upward to the pelvic colon.

From the Department of Obstetrics and Gynecology and the Department of Anatomy (latter's contribution No. 292), Northwestern University Medical School. The clinical aspects of this investigation were discussed by Dr. Arthur H. Curtis in a paper read before the American Congress of Gynecology and Obstetrics, Cleveland, September 12, 1939; this paper is entitled "Special features in the management of surgically difficult malignant growths and kindred lesions of the pelvic viscera."

[1]The subject was a white female, 30 years of age, 5 feet 7 inches tall, weighing 86 pounds (embalmed); the abdomen and pelvis were completely free of pathology. The illustrations are two-thirds actual size.

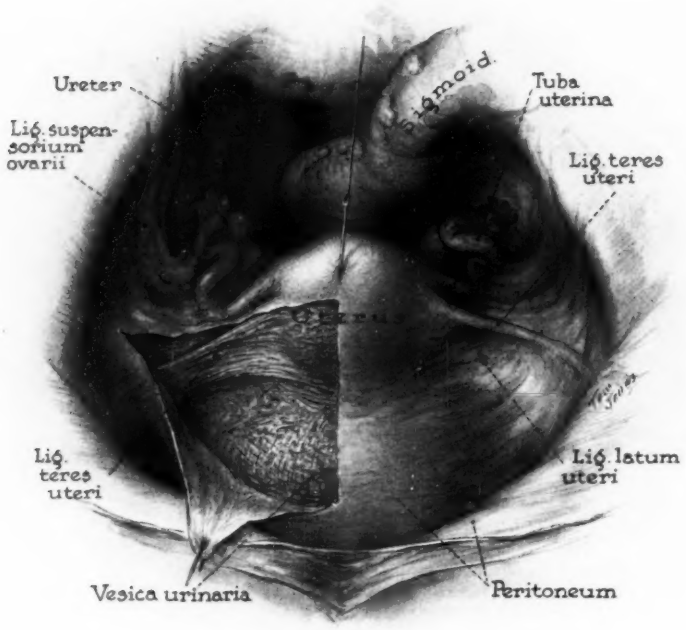

Fig. 1. Subperitoneal tissue of broad ligament, of urinary bladder and uterus. Anterior view. The uterus has been retracted from its normal anteverted position, the peritoneum removed from the body of the uterus, the broad ligament, and the superior surface of the bladder.

In covering the pelvic organs, the degree of fixation of the peritoneum to the intrinsic tissues of these viscera differs with the organ concerned, seemingly dependent upon the thickness and character of the subperitoneal connective tissue. These regional differences in peritoneal anchorage are important enough, in anatomy and gynecology, to warrant special description.

On the uterine corpus the peritoneum is closely adherent to the musculature, there being no demonstrable fascial investment at this superior level (see hereinafter): upon removal of the peritoneum from the posterior surface of the uterus the musculature is at once exposed as far downward as the attachment of the uterosacral ligaments (Fig. 3); the anterior peritoneal leaf is similarly firmly adherent above, but much more loosely attached near the bladder. Over the urinary bladder only a slight amount of areolar tissue separates the peritoneum from the vesical collar of the endopelvic fascia (Fig. 1). Of the three pelvic organs, the rectum is least firmly fixed to its peritoneal covering, a clean separation being easily effected between the latter and the rectal collar of the endopelvic fascia (Figs. 3, 7).

II. EXTRAPERITONEAL "CELLULAR" TISSUE (TELA SUBSEROSA)

The histological fabric of the several supporting structures is fundamentally similar; yet it is important in surgery and in gross

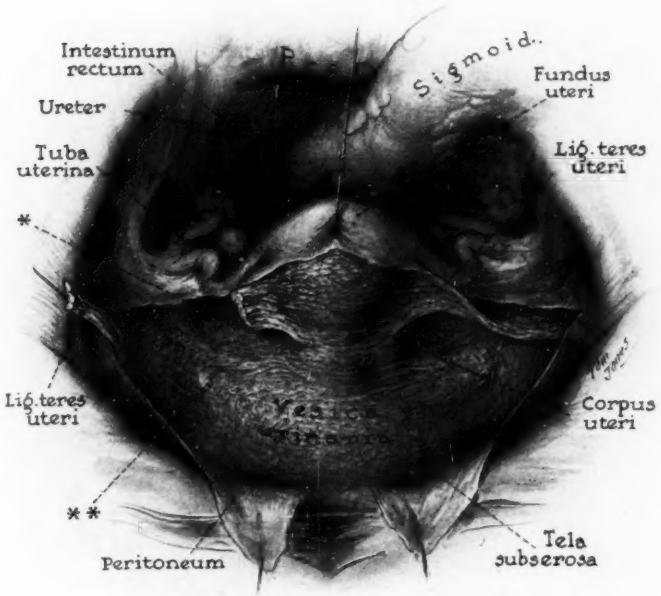

Fig. 2. Structures within the broad ligament. Anterior view. The peritoneum in the ante-uterine part of the pelvis has now been almost completely reflected. The round ligaments exposed; the round ligament of the specimen's right side transected near its uterine extremity. The band-like nature of these ligaments is thus demonstrated; their relation to the musculature of the uterus and to the uterine fascial collar (endopelvic fascia) is likewise shown. *Indicates the area of thin parametrium, **the site of the uterine vein (see Fig. 4).

anatomy to distinguish between the several categories—an areolar or loose packing, a strong sheet-like derivative of muscle fascia, a heavy band-like ligament, a sheath locally thickened to house blood vessels. While consisting chiefly of connective tissue, a considerable amount of muscular tissue may be associated with the fasciæ and the ligaments.

First to be considered is the subserous connective tissue (tela subserosa).

The subserous layer of connective tissue lies between the peritoneum and the fascia covering the internal aspect of the parietal and the abdominal musculature. It provides support for the mesothelial cells of the peritoneum and serves as a packing between the different organs and around the vessels, nerves, and ducts.

In the abdomen, the extraperitoneal tissue, like the peritoneum, is conveniently divisible into two portions, the parietal and the visceral. The former lines the abdominal cavity, while the latter, continuous with that part which lies upon the posterior abdominal wall, is carried forward between the layers of the mesenteries to the several portions of the digestive tube. Whether retroperitoneal or mesenterial, the abdominal part of the subserous stratum is simple in character, being chiefly of the fatty areolar variety.

But in the pelvis the disposition of the subserous tissue in relation to the organs is of a complex nature. Since the peritoneum invests only certain surfaces of the digestive, generative, and urinary organs, a considerable surface area is related to the subserous tissue, either directly or indirectly; it is directly related whenever the tubular prolongation of the pelvic fascia is wanting, indirectly wherever this fascial "collar" definitely intervenes between the muscular coat of the organ and the subperitoneal layer. Current descriptions of these relations leave much to be desired. Thus, in Cunningham's textbook, the extraperitoneal tissue is regarded merely as part "of an extensive fascial system which lines the whole of the body cavity, outside of the various

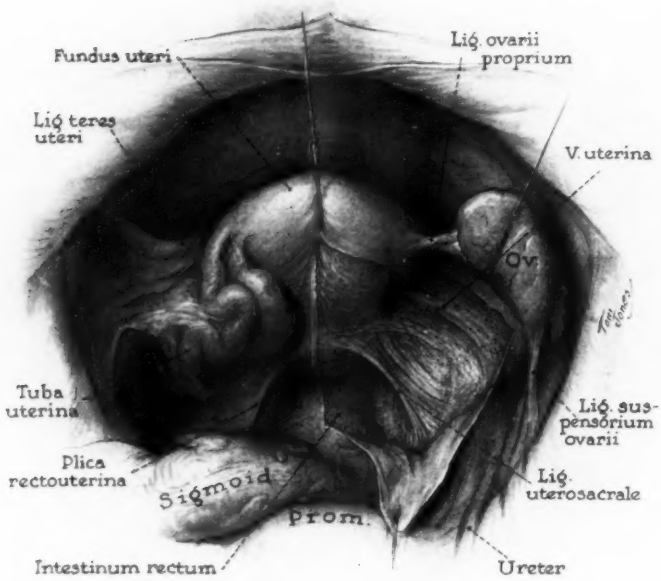

Fig. 3. Broad ligament, uterus; subperitoneal level. Posterior view. The uterus and ovary (with the uterine tube) have been elevated; the peritoneum has been removed from the right half of the body of the uterus and, with it, the posterior leaf of peritoneum of the broad ligament. Thus are exposed the various subdivisions of the parametrial tissue.

serous sacs." It is stated by Cunningham that for the rectum it forms a thick sheath devoid of fat; that it forms a packing for the parts of the bladder uncovered by peritoneum; and that in the female it constitutes a matrix of the broad ligament, and also occurs as a layer devoid of fat which loosely connects the anterior surface of the cervix uteri with the base of the bladder. That part of the entire stratum which, on the uterus, is said to separate the muscular from the serous coat of the organ and to extend outward between the peritoneal leaves of the broad ligament, is the so called parametrium.[1]

If the subserous layer be considered, logically, as an areolar packing, sometimes fatty in character, it should be separable from the fascial stratum of the pelvic muscles and from the tubular prolongations thereof, and distinguishable by methods of gross dissection from the fibromuscular ligaments which support or suspend the organs; it should likewise be separable from the thicker concentrations of connective tissue which, as do sheaths elsewhere in the body, form a rather discrete covering for groups of vessels. Then, as we have found, it may be said that within the subserous cellular tissue lie imbedded the pelvic organs, the thickened coverings of these viscera and of their larger vessels, and the ligamentous stays which hold the organs in their normal positions.

The gross character of the subserous layer varies in different portions of the pelvis, the differences in texture mainly depending upon whether it immediately invests an organ or merely serves as a filler between the organs and parietes, peritoneum, and pelvic floor.

[1]According to Toldt (1919) the term parametrium was first employed by Virchow (*Archives*, No. xxiii) "for that part of the subserous connective tissue of the pelvis, abundantly supplied with blood vessels and lymphatics, that lies beside the cervix and the upper part of the vagina, and between the layers of the broad ligament of the uterus at its lower and inner part." As Toldt points out, the term parametrium is clinical rather than anatomical; since there is no line of histological demarcation between the parametric, paravesical and pararectal tissue, the use of the name becomes a matter of clinical convenience.

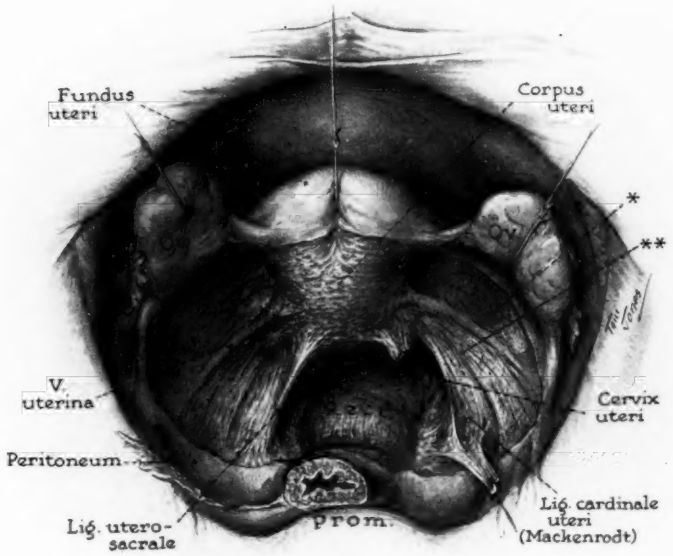

Fig. 4. Supporting structures of the uterus. Posterior view. The entire posterior leaf of peritoneum has been removed from the broad ligament. On the right side the uterosacral ligament has been cut to show the depth of the recess for which it forms the roof (see left side, intact). *Indicates the area of thin parametrium, **the thicker part which forms a sheath for the vessels.

Vesical part. On each inferolateral surface of the urinary bladder the subserous tissue is of a loose consistency, so easily dissectable that the organ may be mobilized by blunt dissection. On the superior surface it is also thin but somewhat stronger; here it is so intimately fastened to the fascial investment derived from the pelvic diaphragm that separation of the overlying peritoneum is rather difficult. At the base of the bladder, although surgically dissectable by blunt dissection, this tissue is likewise resistant, rendering the connection between the fascial coverings of bladder and uterus (and vagina) a strong one; here, too, it contributes to the substance of the vaginovesical ligaments ("pillars of the bladder"). These pillars fasten the uterus firmly to the bladder; but between them the two viscera are separable—an important consideration in the repair of urethrocele and cystocele. The uterus and bladder are not, then, so intimately held together that their adjacent fascial collars, with the intervening cellular (or areolar) tissue, can be considered as constituting an indiscriminate "vesico-uterine septum."

Uterine part. Over the fundus of the uterus, and upon the anterior and posterior surfaces of the body of the organ, the subserous layer scarcely exists as a grossly discernible stratum; but on either border of the body of the uterus it is continuous with the portion of the parametrium situated between the uterine tube above and the uterine vein below; this tissue is finely areolar in character, similar to that intervening between the layers of the mesentery in a spare subject; it is so sparse that, when one peritoneal layer of broad ligament is removed, the thin areolar stratum, with remaining peritoneal leaf, falls away loosely.

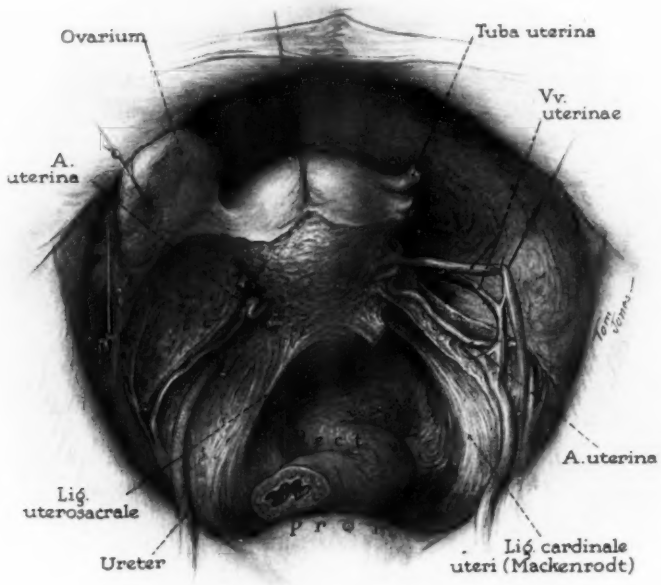

Fig. 5. Structures within broad ligament, vascular (mobilized) and ligamentous (defined or cut). On the right side the uterine tube and the round ligament have been cut near the uterus, the structures inferior to the tube shown in detail—the contents of the whole ligament now being of chief interest, in their interrelationships. The uterine tube and round ligament have been removed except at their uterine extremity, the thinner part of the parametrium dissected away to expose the cut margins (at arrows) of the heavier tissue which houses the uterine vessels; thus is shown the thickened basal part of the parametrium which becomes the cardinal ligament. On the left side, for purposes of comparison, only part of the fibrous tissue has been removed; the difference between tissue superior and inferior to the vessels is made evident.

But beginning with the level of the broad ligament branch of the uterine vein the general tissue lodged between the leaves of the broad ligament becomes tenacious and is continuous basally with the even tougher fibrous material of the cardinal ligaments (see hereinafter). In this lower half of each broad ligament the entire collection of tissue is thus separable into an exceedingly thin areolar layer, immediately subserous in position, and a more tenacious fibrous matrix in which the uterine veins and arteries are placed. Since the fibrous vascular sheath is so closely associated with the true supports of the uterus, it will be discussed under the heading of "Ligamentous Structures." On the cervix of the uterus posteriorly the subserous layer is inconsiderable, separating the collar of endopelvic fascia from the peritoneum. In front, as mentioned above, it is resistant, fastening the fascial covering of the cervix and the vagina to that of the bladder.

Rectal part. Although the uterus and vagina are in contact with the urinary bladder, they are close to the intestinal tube only in the latter's terminal portion. Situated in the posterior part of the lesser pelvis, the rectum is closely applied to the surface of the sacrum and coccyx, following their concavity; in its upper two-thirds the rectum is invested by

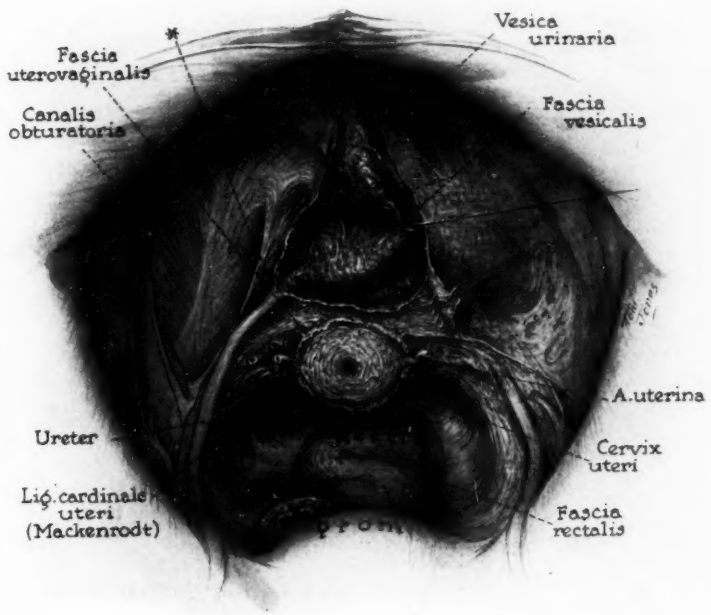

Fig. 6. Broad ligament, basal structures. Ligamentous supports of bladder and uterus and fascial coats of pelvic organs. In the midportion of the pelvis, on the right the uterine vessels have been excised, the remainder of the cardinal ligament retained for comparison with the structures exposed by deeper dissection on the left. On the left side, the veins have been cut near their point of emergence from the uterine wall where they form a pedicle, elongated vertically. The ureter is shown in its surgically important relation to the uterine artery, and to the fused fascial sleeves of the bladder and vagina. The vesical artery has been retained.

In the anterior part of the pelvic cavity on the right side the fascial covering of the bladder has been partially stripped away, leaving the muscular coat exposed on the superior surface. On the left side, the vesical layer of the endopelvic fascia has been freed, and that part of the bladder has been drawn toward the right in order to demonstrate the continuity of the diaphragmatic fascia and the vesical fascia. The fascia of the pelvic diaphragm is now clearly revealed, together with its upward-directed vesical and uterine collars.

peritoneum on the anterior and the lateral surfaces, and is therefore separated from the uterus by the space of the recto-uterine pouch. But below the peritoneal level the intestinal tube is imbedded in the subserous connective tissue to a point just beyond the tip of the coccyx, where, continuing as the anal canal, it makes a sharp angle with the rectum and pierces the pelvic diaphragm. Only in the retroperitoneal part of its course is the rectum related to the vagina, their fascial collars, derived from the superior fascia of the pelvic diaphragm, being close together. Here the tissue of the contiguous fascial investments is not fused to form "ligaments" corresponding to the "pillars" of the bladder. The organs may be mobilized readily, since a seam of areolar consistency separates adjacent surfaces of their fascial envelopes (see "Endopelvic Fascia", hereinafter). The fascial envelopes, with intervening cellular tissue, make up the "rectovaginal septum" of standard descriptions.

III. LIGAMENTOUS STRUCTURES

From even a cursory reading of the anatomical and surgical descriptions of the "liga-

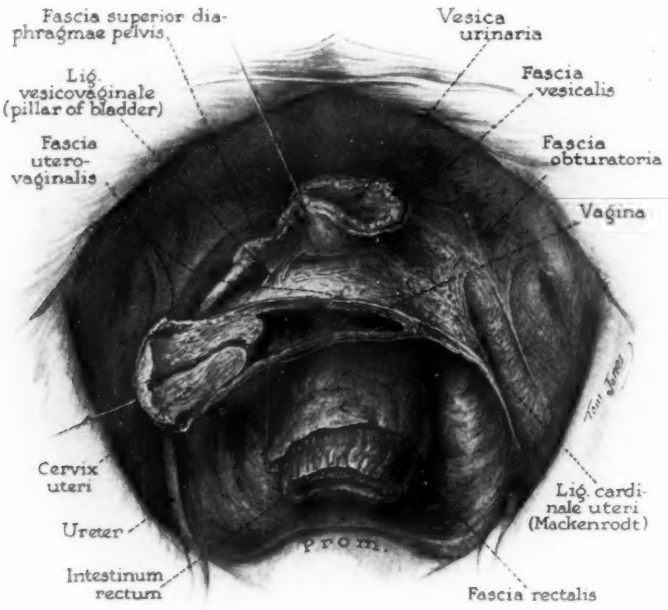

Fig. 7. Endopelvic fascia (visceral investments); ligamentous supports of the viscera. The bladder has been cut down to the trigonal portion, leaving, however, the ureter on the left side. The cervix of the uterus and the vagina (upper two-thirds) have been halved sagittally, the uterine collar of endopelvic fascia separated from the muscular wall. On the right side a similar continuity is demonstrated—as is the relation of the fascial collar to the cardinal ligament. By drawing apart the bladder and the uterus, the fusion of their adjacent collars (laterally the fusion producing a ligamentous connection) is evident. The looser fascial collar of the rectum is also mobilized.

ments" of the pelvis it is evident that current accounts require elucidation, if not drastic revision. The conventional listing of peritoneal folds, obliterated vessels and ducts, fascial bands, and heavy fibrous bands as ligaments presents the student and practitioner with a confusing list of "supports" which, actually, are very different in structure and consequently unlike in function.

Ligamentous supports of bladder. The reflections of the peritoneum from the superior surface of the bladder to the walls of the pelvis are, according to Morris, sometimes described as the superior, lateral and posterior *false ligaments.* Additionally, there extends from the apex of the bladder to the umbilicus a fibrous cord, the remains of the embryonic allantois, which is termed the middle umbilical ligament of the bladder. In addition to these structures certain thickenings of the endopelvic fascia, where it comes into relation with the bladder, constitute what are termed the *true ligaments.* Two such thickenings are said to extend, in the female, from the lower part of the anterior aspect of the bladder to the pubic bone and constitute the middle pubovesical ligaments, with which muscle fibers (musculus pubovesicalis) are usually associated.

It seems entirely without reason to term as a "ligament," even though recorded as a "false ligament," a simple reflection of the peritoneum; the employment of the term is misleading, since the peritoneum lends only such support to the urinary bladder as it would to any retroperitoneal viscus. Similarly, the adult remnant of the allantoic duct, being little more than a group of fibrils sometimes scarcely discoverable in the subperito-

neal tissue of the anterior abdominal wall, does not merit designation as a ligament.

Yet the bladder possesses an effective support in the fascial covering which it receives from the superior surface of the pelvic diaphragm; wing-like elevations of the fascial envelope (assumedly the pubovesical ligaments) offer special support, as do areas of fusion of the vesical with the vaginal collar of fascia (see "pillars of bladder," hereinafter). It should be further noted that these areas of continuity, together with the ligamentous extensions of the vagina and uterus form a serial group of connections which hold the organs in apposition between the pubis and sacrum.

Ligamentous supports of uterus and vagina. In addition to anchorage offered by the uterine tubes above and the vagina below, the uterus is described in textbooks of anatomy as possessing eight other important connections. Certain of these are merely peritoneal folds passing from the uterus to neighboring structures, while others are subperitoneal bands of connective tissue and smooth muscle. By some authors, in spite of the differences in character, all of these supports are placed in the category of "ligament," and are said to be eight in number: one anterior; one posterior; two round ligaments; two lateral or broad; two uterosacral.

The anterior ligament consists simply of the peritoneum, which is reflected on the superior surface of the bladder from the anterior surface of the uterus.

The posterior ligament consists of the fold of peritoneum which is reflected from the back of the posterior fornix of the vagina to the front of the rectum; this is elevated bilaterally to form two crescentic folds of peritoneum, named the sacrogenital or rectouterine folds; these pass backward from the cervix, on either side of the rectum, to the posterior wall of the pelvis. They contain a considerable amount of fibrous tissue and smooth muscle fibers and constitute the uterosacral ligaments (see below).

The lateral or broad ligaments are wing-like in form and consist, on each side, of a transverse duplicature of the pelvic peritoneum. Through much of their extent the apposed peritoneal layers lie close to each other, but laterally and inferiorly they deviate, going over into the parietal peritoneum on the lateral wall of the pelvis, and being reflected upon the bladder in front and the rectum behind. The areolar contents have been already described; the special nature of the vascular compartments and of the cardinal and uterosacral ligaments which lie at the base of the broad "ligament" will be discussed presently.

The round ligaments are described by Cunningham as flat, cord-like bundles of fibers; by Spalteholz the round ligament is described as a rounded smooth cord as large as a goose quill. In structure, it is described by Gray and Spalteholz as consisting of connective tissue and smooth muscle; by Cunningham as containing, at the uterine end, smooth muscle fibers continuous with those of the wall of the uterus, and more laterally consisting chiefly of fibrous tissue; this description is repeated, in substance, by Piersol. Traversing the inguinal canal, and carrying ahead of it a few fascicles of the internal oblique muscle, it appears at the abdominal inguinal ring in the substance of the mons pubis. Finally, according to the various authorities, it may terminate in the fatty subcutaneous tissue of the mons, spread out in a number of diverging fibrous bands which are attached in part to the periphery of the ring or may become fixed to the front of the pubic symphysis.

The uterosacral ligaments lie within plicæ of crescentic form, termed the recto-uterine (or sacrogenital) folds of peritoneum; the folds themselves form the lateral boundary of the recto-uterine pouch. It has become customary in gross anatomy to regard the entire content as divisible into two sets of bundles: (1) those which pass from the upper part of the cervix to the sides of the sacrum opposite the lower border of the sacroiliac articulation, to constitute the uterosacral ligament; (2) those groups of fibers which extend from the uterine cervix to the anterior surface of the sacrum and to the rectum and make up the recto-uterine muscles; at their uterine extremity, the muscular bands of the two sides, continuous with each other behind the cervix, form a transverse elevation, the *torus uterinus*.

The transverse cervical ligaments (Mackenrodt) are not recognized in gross anatomy. These ligaments are frequently discussed in medical journals and textbooks; yet, aside from Mackenrodt's original account, correct in essentials but not supported by anatomical dissections, nothing more than a vague description of these structures is discoverable in the general literature.

Anterior ligament. This so called anterior ligament is merely the peritoneal investment of the uterus, and it possesses none of the anatomical features of a ligament; it is supportive only to the degree that any serous layer would be where it passes between adjacent viscera; in this instance the serosa contains no specially thickened fibrous elements.

Posterior ligaments. The posterior ligaments are similarly peritoneal, but differ from the anterior in being elevated, as crescentic folds, over musculofibrous tissue of the uterosacral ligaments (see hereinafter).

Broad (lateral) ligaments. These belong in the same category. Primarily peritoneal, the broad ligaments also consist of certain

structures placed between the serous folds.[1] Of these contents, the contained parametrial tissue and visceral blood vessels now call for discussion; the round ligaments will receive consideration under a separate heading.

The loosely areolar cobwebby material encountered between the layers of the broad ligaments appears as a definite layer of areolar tissue, so thin that, when the investing peritoneum is removed, it drops away anteriorly, to form a depression of roughly triangular outline (Fig. 3). The superior boundary of the area of thin parametrium is the uterine tube; the inferior boundary is a ridge which, by palpation, even before dissection, is discovered to contain the obliquely coursing broad ligament branch of the uterine vein (Figs. 4, 5); this vein marks the site of the upper border of a *vascular compartment*, which encases also the somewhat more inferiorly placed transversely coursing uterine artery and accompanying vein (the vein accompanying the artery lies immediately beneath it, not exposed, in this dissection). Near the uterus, parallel with it, are the ascending and descending branches of the artery (Fig. 5).

Since, in surgery, the walls of the vascular sheath with the contained uterine vessels appear as a considerable mass continuous with the subjacent heavy ligament, it has become customary to consider the entire assemblage as the cardinal (transverse cervical, Mackenrodt) ligament.

From the top of the vascular compartment downward the parametrium thickens and consists of two definite layers; posteriorly it is continuous with the uterosacral ligament; the latter is blended in turn with the more dense portion of the cardinal ligament (exposed on the right, Fig. 4, by the removal of the uterosacral ligament): so intimate is the connection of the two that segregation is rather artificial. An explanation for the valuable support to the uterus obtained by suturing together the uterosacral ligaments with silk is now apparent.

Actually, the broad ligament, so called, is a mesenterial support of modified form, which not only invests a viscus and its ducts and transmits vessels and nerves within a special sheath, but also contains true ligaments of both anterior abdominal and posterior pelvic attachments; these are the round, the uterosacral, and the cardinal ligaments—which structures will now be described.

Round ligaments. Just as, in a posterior direction, the peritoneum is lifted by presence of subjacent uterosacral ligaments, so in an anterior direction it is elevated by round ligaments en route to abdominal wall.

In careful removal of the anterior peritoneal layer of the broad ligament, the elevation apparent immediately below the uterine tube (Fig. 1, observer's right) is found to be produced by the superior margin of the round ligament (cf. Fig. 1, left).

Near the uterus, the "round" ligaments are found to be flat bands, not round cords. Each ligament is inserted broadly into the uterus, spread out in its attachment to the uterine musculature in a manner analogous to the spread of the pectoralis muscles on the chest, the attachment to the uterus extending obliquely downward to the level of the uppermost uterine vein, described later (Figs. 2, 4). At the uterine extremity of the ligament, for a distance of 2.5 centimeters, the peritoneum dissects away from the ligament with difficulty. This suggests that some of the externally placed muscle fibers of the round ligament insert directly into the peritoneum, much as do the muscle fibers of the upper corpus. Becoming more fibrous and narrowing as it passes anterolaterally, the ligament finally becomes imbedded in the more abundant areolar tissue existing near the pelvic wall. Within the inguinal canal the round ligament diminishes gradually in caliber, yet it may be considered to be firmly anchored to the abdominal wall, through whose layers it passes to the subcutaneous inguinal ring. In emerging from the ring, the ligament is frequently no thicker than a violin string, sometimes so small in the dissected body as to be scarcely discoverable[2].

[1] Obviously "fold" (plica) would be more suitable than "ligament" as naming these lateral duplicatures of the pelvic peritoneum, but old names in anatomy and surgery, however illogical their employment may be, are usually persistent. Were structures termed "broad folds," then as peritoneal *plicæ* they would contain true ligaments, the round and the cardinal ligaments, just as the recto-uterine folds contain the uterosacral ligaments.

[2] Externally, round ligament is contained in prolongation of superficial fascia carried downward into labium (Anson, McVay. Anat. Rec., 1938, 71: 401).

The inferomedial limit of the round ligament marks the point at which the superior edge of the fascial investment of the uterus is definable grossly (cf. Fig. 6): it may therefore be stated that over an area of 2 centimeters or more on the anterior surface of the uterus the round ligament is continuous with the superior margin of the heavy fascial collar which invests the vagina and the lower portion of the uterus; in other words, in front, the uterus is supported superiorly by the round ligaments and inferiorly by the special collar derived from the endopelvic fascia. A hitherto inexplicable clinical observation is herewith elucidated; it has been noted that patients with marked retrodisplacement of the uterus are prone to have a low location or "skidding" downward of the bladder in relation to the uterus; also, "advancement of the peritoneal reflection," placing the vesico-uterine fold and bladder higher upon the uterus, has afforded surprising support in the operative correction of retrodisplacements; an explanation is offered in the support afforded by the vesical collar, which by this procedure is attached more intimately and at a higher level on the uterus.

Uterosacral ligaments. Stretching away from the posterolateral aspect of the uterus on each side of the pelvic cavity is a uterosacral ligament (Figs. 3, 4, and 5); beneath its peritoneal covering it forms the lateral boundary of the pararectal fossa at the latter's superior plane (Fig. 3, left side).

The uterosacral bands are true ligaments; they contain, as regularly described, connective tissue and smooth muscle arranged in "robust bands"; but the latter are not, according to the observations of the present authors, arranged as separable muscles.

Freed of its serous investment, the uterosacral ligament forms a prominently jutting ligament-like ridge at its uterine extremity, whereas the sacral extremity is of such even contour that it bears little resemblance to a true ligamentous band. The uterosacral ligaments are of musculofascial consistency, resembling the round ligaments in this respect. Above, the ligament is continuous with the posterior leaf of the vascular compartment; the connecting bridge, though more condensed than areolar tissue, is not particularly firm. The lateral margin of the ligament is continuous with the adjacent posterior firm layer of the Mackenrodt ligament.

In consideration of the fact that the uterosacral ligament is blended lateralward as a unit with the Mackenrodt ligament (Figs. 3, 4, and 5), the confusion which has existed relative to the support afforded by the uterosacral ligaments should now be clarified; forming the medial border of, and integrated with, the Mackenrodt ligament, division of the uterosacral ligament and the adjacent parametrium releases uterine fixation and support proportional to the extent to which the scissors cut transversely lateralward through these tissues.

Cardinal or transverse cervical ligaments (of Mackenrodt). When the uterosacral ligaments are removed the heavier adjacent structure with which they are continuous, which remains on each side, is the Mackenrodt (cardinal) ligament of the uterus. Included with this is the definite fibrous sheath covering the vessels (Fig. 5). This vascular compartment suggests in general structure the covering of the carotid or the femoral vessels, but it differs from these investments in being situated at the apex of a triangular septum of heavy fibrous tissue. The vascular "core" consists of the uterine artery and veins with their immediate investures, placed essentially transversely in the base of the broad ligament; the uppermost vessel is a uterine vein, obliquely traversing the broad ligament at the level which marks the superior border of the fascial collar of the uterus. The fascial collar may be considered as continuous with the walls of the vascular compartment, since extensions of the fascia accompany the ascending and descending branches of the vessels in their distribution along the uterus and vagina. The sheath of the vascular compartment may be separated from the vessels; when cut at the upper margin (Fig. 5, right) it resembled an envelope trimmed along its superior edge and opened.

The entire mass of tissue constituting Mackenrodt's ligament spreads tent-like lateralward toward the pelvic wall, to become inserted fan-shaped into the fascia overlying the obturator muscle and the superior fascia of the pelvic diaphragm; it also merges medially and inferiorly into the uterovaginal

and vesical fascial envelopes, and is integrated posteriorly with the uterosacral ligament.

Upon both gross and microscopical study, including special differential stains, it appears that there is a limited number of muscle fibers in the Mackenrodt ligaments, other than those encountered in the walls of the blood vessels in this exceedingly vascular tissue. The tensile strength and elasticity of the upper, paracervical, portion of Mackenrodt's ligaments is evidently ascribable in large measure to the connective tissue components of the walls of the veins and the unusually abundant connective tissue accompanying the blood vessels. A proper appreciation of the venous supply of this tissue is best obtained by observations at operation after surgical dissection of the overlying peritoneum, integrated with microscopical study of selected material removed together with the uterus.

The authors are in accord with the opinion of Mengert, whose experiments indicated that the Mackenrodt ligaments, and their perivaginal continuations, are the chief supports of the uterus.

Ligamentous supports of rectum. The uterosacral (peritoneal) folds, mentioned previously in connection with the ligaments of the bladder, are sometimes reckoned among the supports of the rectum. The peritoneal folds contain fibrous tissue; their free edges are semilunar and sharp; they curve around the rectum above the ampulla, which they partially roof in (Piersol).

Except for its peritoneal investment and the hemorrhoidal vessels, the rectum, in so far as observed in the present study, is without special ligamentous supports; the rectouterine muscles, often described as part of the uterosacral ligaments, were not seen by the present authors. But, through its continuity with the anal canal—which is firmly fixed to the pelvic floor—the rectum is anchored at its termination; further stability is gained through the presence of the fascial collar derived from the superior layer of the pelvic diaphragm (see hereinafter).

IV. ENDOPELVIC FASCIA

The fascial covering of the pelvic muscles is regularly described as being carried upward on the viscera as the latter pierce the pelvic diaphragm to reach the exterior. But, as here recorded, the conventional descriptions draw no careful distinction between fascia, parametrium, and ligament. In current dissections the "collars" derived from the pelvic fascia were found to be exceptionally definite structures that could be freed from the intrinsic tissue of each organ and from the general extraperitoneal layer.

Vesical part. As already pointed out, on the urinary bladder, and especially near the lateral margin (superior view), the subperitoneal areolar tissue is a definite layer, as readily demonstrable as it is in the upper part of the broad ligament. Locally thinned over the middle area of the superior surface of the bladder, it blends with the fascial sheath of the bladder (vesical layer of the endopelvic fascia). At the meeting point of the inferolateral and superior surfaces, the layer is carried upward upon the wall of the true pelvis as a wing-like leaf (Fig. 2). This arrangement is regularly seen in the dissecting room, where, upon reflecting the peritoneum, the margins of the bladder seem prolonged superolaterally. In the iliac fossa, over the iliac fascia, the layer becomes cobweb-like in texture and is no longer a readily dissectable stratum. At the sides of the bladder, between the latter and the pelvic diaphragm, the layer assumes the form of a characterless packing, and is easily dissectable with the finger.

In transition from the uterus to the bladder, the subserous tissue increases in thickness and density and merges into the vesical collar of the endopelvic fascia (Fig. 2). To each side of the lateral margin of the bladder the thickened subserous cellular tissue is attached in such a way that the true triangular outline of the organ is masked; when dissected from above, it is found that these upward directed wings finally become the inconsiderable stratum of fatty areolar tissue which intervenes between the peritoneum and the iliac fascia in the greater pelvis; at the pelvic brim, between the greater and the lesser pelvis, a continuation of this same tissue forms the housing for the iliac vessels; in it, anteriorly, the middle and lateral umbilical ligaments are imbedded, while posteriorly it contributes to the fibrous substance of the infundibulopelvic or suspensory ligament of the ovary and constitutes the layer in which the aorta and the inferior vena cava are situated.

Over the superior surface of the urinary bladder, the tela subserosa merges with the vesical layer of the endopelvic fascia, which,

here, is exceedingly thin. But the vesical fascia is prominent on the inferolateral surfaces, carried outward inferiorly as the superior fascia of the pelvic diaphragm (Fig. 6). When cut, it appears as a definite "collar." In being carried lateralward and upward at the pelvic floor, except anteriorly, the endopelvic layer does *not* descend to the point at which the urethra pierces the urogenital diaphragm; it sweeps toward the pelvic diaphragm at a relatively high level; its width is therefore much greater than the width of the urethra, being 3.0 centimeters wide. This means that the urethra itself lies within a subfascial partition (formed by continuity of visceral and diaphragmatic parts of the pelvic lining). As established by the earlier series of dissections (Curtis, Anson, and McVay, 1939), the urethra receives an investment from the structure next below, namely the urogenital diaphragm.

The urinary bladder can be rather readily enucleated from the fascial envelope in which it is housed (Fig. 6); like the outline of the viscus itself this fascial covering is triangular in outline, the base situated posteriorly, against the cervix and vagina, the apex pointed anteriorly toward the pubic symphysis. In becoming continuous with the superior fascia of the pelvic diaphragm the layer is lifted into a wing-like fold similar to that which is related to the vagina.

As the tela subserosa is removed from the region between the bladder and vagina, it is found to become denser, less similar to a true subperitoneal tissue, as the pelvic floor is approached. Near the point where the vesical and vaginal fascial collars arise by being carried upward upon the organs, the intervening subserous tissue is so distinctly fibrous in nature that the fascial coverings are difficult to separate. So strong is the fusion that bilateral connecting bands are formed; these are the "pillars of the bladder" (Fig. 7). At this point, mention of a surgical landmark may not be amiss: the ureters are situated immediately above (anterior to) and 1 centimeter lateral to the bladder pillars.

Uterovaginal part. It has already been stated that the fascial covering of the vagina and uterus sweeps upward from the pelvic floor, encasing these tubular structures (see Curtis, Anson, and McVay, Fig. 1); it is likewise established that these tubular collars thin out as they ascend, becoming such an inconsiderable layer over the body and the fundus of the uterus that the peritoneum seemingly lies directly upon the muscular coat of the organ (Figs. 2, 3, and 4). Proceeding downward, it is at the approximate line of junction of the body and the cervix of the uterus that the fascial collar first becomes definable; this is the level at which the round ligaments (Figs. 1 and 2) and the uterosacral and the cardinal ligaments (Figs. 3, 4, and 5) are attached to the uterus. Inferior to this level the uterine "collar" of fascia becomes distinct and can be separated from the muscular coat; it becomes thicker as it invests the cervix (Fig. 6) where it is the strongest of the three tubes of the endopelvic fascia. In general terms it might be described as being pierced by the uterine vessels along each lateral margin of the uterus (Fig. 6; cf. Fig. 5); actually, its tissue is prolonged upon these vessels as a sheath and is continuous lateralward with Mackenrodt's ligament.

Inferiorly, the thick collar covering the cervix is readily traceable upon the vagina, separable from the latter's intrinsic musculature (Fig. 7); extending lateralward and backward, it is continuous with the basal portion of the parametrium; at the level of the pelvic floor it spreads out as the superior fascia of the pelvic diaphragm. In form, the vaginal collar is wing-like, similar in character to that figured for the bladder in the earlier set of drawings (Curtis, Anson, and McVay, 1939, Fig. 1); it is prominent in dissection and exceptionally strong, yet it has not been described in gross anatomy. These wing-like fascial bands follow the inclination of the vagina; their forward inclination accounts in part for the capaciousness of the recto-uterine recess (Fig. 7; cf. Figs. 3 and 5).

Since the course of the ureters is a matter of surpassing importance in surgery of the pelvic organs, comment upon their anatomical relations to neighboring structures seems warranted. At the brim of the lesser pelvis each ureter lies immediately medial to the attachment of the infundibulopelvic (suspensory) ligament, exactly in the region where

the ligament is clamped and divided in those cases in which the ovary is removed at hysterectomy. Therefore, in peritonization following removal of the uterus and the ovaries, the ureter is dangerously near the lateral limit of the surgical field, and the peritonizing suture should never be deeply placed without preliminary palpation of the ureter. The ureters converge as they approach the bladder; therefore, while each is located 4 centimeters from the uterus at the level of the internal os, the ureter is only 1.5 centimeters from the lowermost portion of the cervix at the point of closest proximity. As has become clear from the discussion, the ureters, in their downward course, lie beneath the tent-like lateral extensions of Mackenrodt's ligaments, and pass under the uterine vessels (Fig. 6). At the level at which the pelvic surgeon usually places clamps on the vagina in performing a simple complete hysterectomy, the ureters are approximately 8 centimeters apart. As the ureters approach the bladder they are situated just anterior and 1 centimeter lateral to the pillars of the bladder; the ureter is imbedded in heavy fibrous tissue which is prolonged upon it from the musculofascial covering of the bladder—a structural fact important in radical hysterectomy for cancer. In this fibrous investment pass the ureteral lymphatics, creating a pathway for drainage from the cellular tissue contained within Mackenrodt's ligament.

In summary, it may be said that the vaginouterine collar (especially in its strong cervical portion) serves as anchorage for the uterus, since into it insert not only the prominent ligaments of sacral attachment, but also, bilaterally, the thickened parametrial "tents," or Mackenrodt ligaments, including the vessels contained therein. There are also the anteriorly placed supports which have been described in connection with the urinary bladder; these are produced through local fusion of the adjacent surfaces of the uterine and vesical collars of endopelvic fascia.

Rectal part. The rectum possesses a very definite fascial collar, readily separable from the muscular coat of the tube; it is a loose investment, thinner than the corresponding coverings of the bladder and the uterus (Fig. 7).

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ANESTHESIA IN CESAREAN SECTION

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IN the rather scanty literature on cesarean section very little mention is made of the anesthetic and even less of its effect upon the respirations of the infant. When artificial respiration is needed or pneumonia follows initial respiratory difficulties, it is too often dismissed as due to toxemia or other ill health in the mother. In reality, the type of anesthetic used for the operation plays a very definite part in the baby's start in life. No form of anesthesia nor method of resuscitation will save a baby with very marked defect of brain or heart. It is doomed by congenital defects for which there is no remedy. Many others, however, fail to survive the first few hours because their respiratory mechanism is unable to function properly, due to depression by the anesthetic or sedative. It is impossible to anesthetize or sedate the mother by inhalation or narcotics without anesthetizing the fetus. The drug is absorbed at the time when the fetal respiratory and cardiac centers are at their lowest ebb following prolonged labor or damage secondary to maternal ill health. Most babies, particularly if the operation is at the time of election, will withstand this terminal depression and breathe spontaneously. The occasional one, however, is unable to cope with the depressing effect of the anesthetic and breathes only after resuscitation. Too often the respirations remain unsatisfactory and atelectasis leads to pneumonia or death. Since it is impossible to predict in advance the exact state of the respiratory system, safety demands the use of the anesthetic which will add least strain to the already overburdened fetus. The anesthesia in question in this series proved to be spinal with straight cyclopropane-oxygen, or nitrous oxide-oxygen without ether a close second. Ether is definitely contra-indicated particularly after a heavy sedative.

In a previous publication (2) it was shown that with spinal anesthesia the babies breathed much better than with nitrous oxide-oxygen-ether. Since then, general anesthesia has been revolutionized by the introduction of cyclopropane and the carbon dioxide absorption technique for all gases (1, 3). Meanwhile, spinal anesthesia has remained at a standstill. Results with this type of anesthesia are as striking as ever and it remains the anesthetic of choice, but the newer methods of general anesthesia present so much keener competition that it is no longer necessary to force spinal anesthesia on a patient or surgeon who objects to it. It cannot be emphasized too strongly that the alternative for spinal anesthesia is either cyclopropane or nitrous oxide alone without ether. Ether, by itself or added to these gases, is very definitely depressing to the fetus and should be used only after the most careful consideration of the relative merits of spinal anesthesia. These statements are based on an analysis of the 279 cesarean sections performed in St. Michael's Hospital, Toronto, in the past 8 years. This represents 1.9 operations per 100 normal deliveries and indicates the use of conservative surgery with an inevitably high incidence of difficulties. Further, 109 mothers were in abnormal health and 157 were in active labor 4 to 72 hours. Ages ranged from 15 to 48. Almost one-third of the patients returned a second, third, or even fourth time, and 65 individuals accounted for 141 babies. This repetition of operation suggests matching the anesthetic to the patient's condition so that she will not approach a later operation in dread of it. The causes of operation were: simple contracted pelvis, 170; abnormal health in mother, 109. Of the unhealthy mothers, 78 had ample pelvic measurements but the condition was serious enough for pregnancy to be terminated by section instead of delivery.

In this unselected series the anesthetics used were: spinal, 141 or 50.6 per cent; cyclopropane or nitrous oxide, 70 or 25.1 per cent; ether, alone or with cyclopropane or nitrous oxide, 65 or 23.2 per cent; local 2, and pentothal 1. The rôle of each type can be deter-

From the Department of Anesthesia, St. Michael's Hospital.

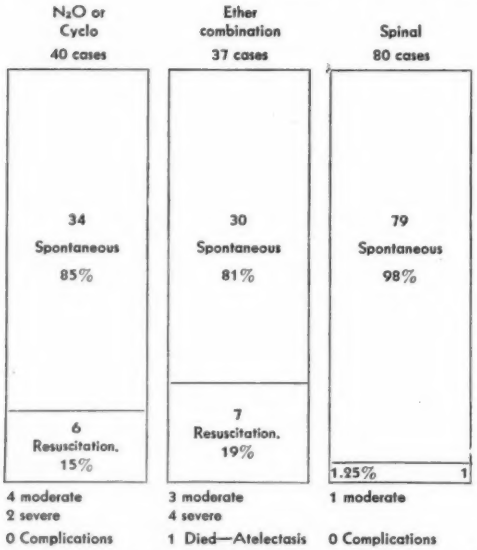

Chart 1. Infant respirations in 157 cases. Mother and baby both normal. Mother in good health with contracted pelvis or previous cesarean. Baby at term with no congenital defect, clinically or at autopsy.

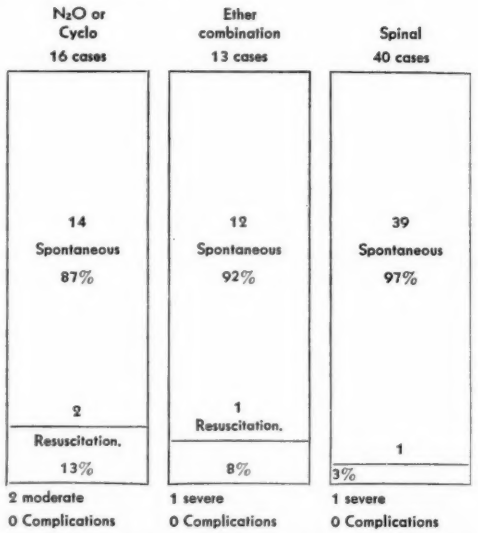

Chart 2. Infant respirations in 69 cases with mother abnormal—toxemia; eclamptic convulsions; prolonged labor, 24 to 72 hours; pyelitis; cardiac decompensation; placenta previa and hemorrhage; upper respiratory infection; carcinoma; nephritis; syphilis; epilepsy; diabetes; asthma; goiter; fibroids; ovarian cyst. Baby normal at term with no congenital defect.

mined only in conjunction with a consideration of the health of the mother and child upon whom it is used. The effect of one anesthetic on the premature baby of an eclamptic mother should not be set against the record of a different anesthetic on the fully developed infant of a healthy mother. To avoid this error, the series has been divided into 4 comparable groups, depending on the condition of the mother and fetus. Chart 1 deals with 157 normal mothers in good health, with simple contracted pelves or histories of previous sections, who produced normal babies at full term with no defects clinically or at autopsy. With gas alone, 85 per cent of the babies breathed spontaneously, i.e., in less than 2 minutes, with no more manipulation than was necessary for the proper clearing of the air passages of mucus or foreign material. In 15 per cent resuscitation was needed such as artificial respiration, oxygen, hot baths, coramine, etc. With ether alone or in combination the results were numerically similar; 19 per cent required resuscitation, but the results actually were not so satisfactory because 4 of these were revived with great difficulty and 1 died in 5 hours. With spinal anesthesia in 80 cases only 1 baby required resuscitation. Most of these babies breathe before the feet are out of the incision and cry lustily before the cord is cut. The difference between the baby born with spinal anesthesia and one when ether was employed must be seen to be appreciated. Even in the case when cyclopropane has been administered the baby does not approach in rapidity of response the one which was born with the aid of spinal anesthesia particularly if a sedative has preceded operation. These were normal babies and this good condition of the fetus has apparently a greater bearing on respirations than has the health of the mother.

This is proved in Chart 2. Sixty-nine normal babies were produced by mothers in abnormal health, many of whom were in the advanced stages of the diseases indicated. In view of the maternal handicap, the results are rather surprising. With gas, 12.5 per cent of the newborn were resuscitated; with ether,

7.6 per cent; and with spinal anesthesia in 40 cases—again the equal of the others combined—only 1 needed resuscitation. While this is definitely favorable to spinal anesthesia, the lack of complications in the entire group seems to indicate that the normal baby does well with almost any procedure.

This is confirmed by Chart 3 which deals with the opposite group of abnormal babies, in which complications were very high despite the good health of the normal mother. Percentages are inaccurate in such a small number, namely, 13 patients, but the bad record of ether cannot be contradicted. In 7 cases, 6 babies were resuscitated and 2 died within 5 hours. Spinal and gas were equal with 1 resuscitation each but without complications.

Again in Chart 4, with 40 abnormal babies and abnormal mothers the complications were very high. Both mother and child were unhealthy; each had one or more of the major obstetrical disorders. This proved to be a disastrous combination with any anesthetic. Forty cases showed 11 deaths from atelectasis superimposed on existing defects. In addition there were 3 stillbirths; the fetus had been delivered without heart beat and had been dead or dying before the commencement of operation. Again the poor result with ether is seen. In 8 cases, 6 were resuscitated and 4 died within 12 hours. Gas and spinal anesthesia were equal with 27 per cent resuscitations and 2 and 3 deaths, respectively. Local and pentothal anesthesia were used only in profound toxemia or hemorrhage with upper respiratory infection. The mothers did well but 2 babies died; both premature infants weighed 3½ and 4 pounds, respectively.

Thus the advantageous effect of spinal anesthesia upon the baby cannot be questioned but it is the opinion of the gynecologists concerned that the postoperative course in the mother is not as smooth as after general anesthesia. Hence, with the introduction of cyclopropane there has been a trend toward it; spinal anesthesia is reserved for specific indications. This is at variance with the experience on general surgical services where, during the same 8 year period, 66 per cent of all abdominal work has been done with spinal anesthesia. The popularity of spinal

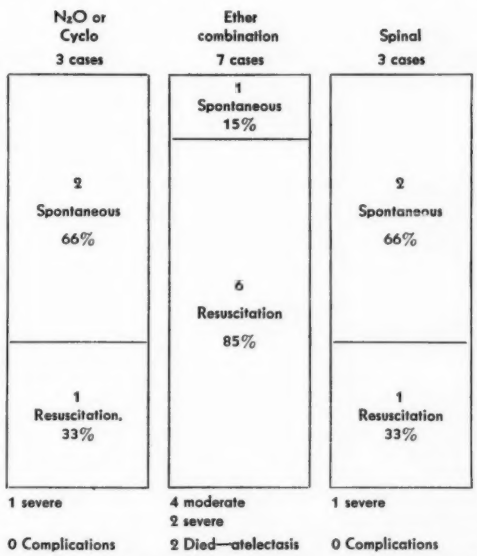

Chart 3. Infant respirations in 13 cases with normal mother—in good health with contracted pelvis and baby abnormal with following complications: prematurity, 6 to 8½ months; underweight, 2½ pounds up; hydrocephalus; spina bifida; hare lip; cleft palate; head injury; large thymus· twins; cardiac distress.

anesthesia in general surgery has been only moderately influenced by the introduction of cyclopropane, since the use of spinal anesthesia in 63 per cent of all abdominal surgery for 1938 represents only a small drop from the peak of 73 per cent in 1935.

However, the opposition to spinal anesthesia in the pregnant woman is quite widespread in many centers. The risk of low blood pressure, particularly if hemorrhage be superimposed on the initial drop, is frequently cited. Against this must be balanced the hazards of general anesthesia, namely, obstruction of the air passages, aspiration of vomitus in the unprepared emergency case, improper aeration of the lungs due to pressure from below, and damage by the anesthetic agent to the already weakened organs and tissues. These may imperil the patient quite as much as the more dramatic circulatory depression of spinal anesthesia. The one group probably offsets the other in any large series in which the surgical risk varies so widely with maternal health. One case of spinal shock was postponed and next day

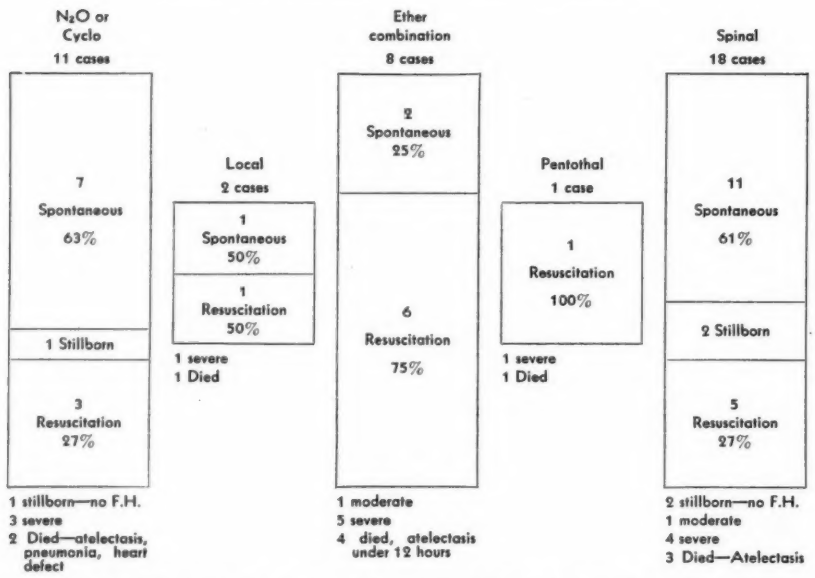

Chart 4. Infant respirations in 40 cases with mother and baby both abnormal, the mother showing following complications: toxemia; eclamptic convulsions; prolonged labor, 24–96 hours; pyelitis; cardiac decompensation; placenta previa and hemorrhage; upper respiratory infection; carcinoma; nephritis; syphilis; epilepsy; diabetes; asthma; goiter; fibroids; tuberculosis. The complications in baby were: prolapsed cord; twins; prematurity, 7 to 8 months; underweight, 2½ pounds up; hydrocephalus; spina bifida; cleft palate; head injury; large thymus; cardiac distress.

handled well with nitrous oxide. One patient did badly with cyclopropane and ether but a week later responded well to spinal anesthesia.

It is frequently stated that the possibility of excessively high anesthesia is greater in pregnancy than in normal health because of altered dynamics of intra-abdominal pressure and circulation. High anesthesia with paralysis of the intercostal muscles and occasionally the diaphragm is a real danger in any spinal anesthetic. It calls for the immediate administration of oxygen, possibly with artificial respiration, until the level of motor anesthesia has receded to a point at which the intercostals regain their respiratory function. During this same 8 year period, in 8,472 operations with spinal anesthesia for all types of surgery, this complication was encountered 10 times with 1 death. Two of these were cases of cesarean section. Despite the relatively high incidence of 2 in 279, careful study of all phases of spinal anesthesia, so widely used in St. Michael's Hospital, leads one to believe that probably this danger is no greater in pregnancy than in other conditions. Certainly spinal anesthesia has proved to be the best anesthetic in operations, such as appendectomy, which have been necessary in the course of pregnancy. In one of the cesarean sections, the intercostals alone were involved and after oxygen inhalations for

TABLE I.—MATERNAL COMPLICATIONS—CARDIAC, RESPIRATORY, CIRCULATORY.

Anesthetic	Cases	Complications during operation			Complications after operation		
		Cases	Per cent		Cases	Per cent	
Spinal	141	12	8.5	4 severe	12	8.5	2 severe 1 death (cardiac)
Ether combinations	65	5	9.2	2 severe	8	12.3	2 severe 1 death (pneumonia)
Nitrous oxide or cyclopropane	70	8	11.4	4 severe 1 death (cardiac)	4	5.6	2 severe
Local or pentothal	3	0	0		0	0	
Total	279	25	8.9	10 severe 1 death	24	8.5	6 severe 2 deaths

35 minutes she returned to bed and in an hour was smoking a cigarette. Next day cyclopropane was successfully used. Her first cesarean operation had been with spinal anesthesia 4 years previously without complication. In the other case of a toxic mother in advanced labor, the diaphragm was involved and artificial respiration was necessary for 25 minutes after which the operation was completed under the original spinal anesthetic. Collapse of the lung had occurred, however, and pneumonia was followed by pleurisy with effusion. Since then 2 additional cesareans have been satisfactorily done with general anesthesia.

Complications (Table I) during and after operation, involving the cardiac, respiratory, and circulatory systems are the only ones in which the anesthetist is qualified to express an opinion as to his responsibility. It will be seen that severe complications occur with each type of anesthesia and that the incidence does not vary greatly. With ether the complications after operation are 12.3 per cent while with the use of straight gas the complications during operation are 11.4 per cent. This is of great significance because even the best anesthetist encounters the occasional patient in whom satisfactory working conditions cannot be obtained without pushing nitrous oxide, or even cyclopropane, beyond the limits of safety. To complete the operation, ether must be added to the gas with the proved dangers to the baby. It is impossible to guarantee in advance that any gas anesthetic can be carried through without some ether. Actually, of the 65 cases classed as "ether combination" only 19 received ether from the start. The 46 remaining commenced with gas anesthesia but ended with sufficient ether to necessitate their transfer to the less safe category. On the other hand, with spinal anesthesia no supplemental inhalation was needed in any case until after the baby had been safely delivered. In 13 cases, or 9 per cent, gas was used to complete an unduly long operation.

SUMMARY

In the mother, pulmonary and cardiac complications are not markedly influenced by the type of anesthetic. This is in accordance with the now universally recognized fact that pulmonary complications vary primarily with the site of operation and length of time on the table. Consequently, the tendency will be for the surgeon or anesthetist to use the anesthetic which he prefers for ordinary abdominal work, such as hysterectomy. The man who dislikes spinal anesthesia in one will probably avoid it in the other. Perhaps this is not unreasonable, since there is an old dictum that the safest anesthetic is the one with which the individual is himself most adept. However, this must not be carelessly carried to the point of endangering the baby, whose safety demands the avoidance of ether. The bad effect of ether reaches its peak in the abnormal baby or with heavy sedation in the mother. Ether can be avoided simply and easily by the use of spinal anesthesia or, with much greater difficulty, by the use of gas alone. General anesthesia is best avoided unless the obstetrician is reasonably sure that the baby is normal and the anesthetist confident that he can complete the work with gas alone. He who denies the baby the safety of spinal anesthesia must accept the responsibility of protecting him from ether; for if this article is not to be interpreted as an argument for spinal anesthesia, it is at least a condemnation of ether.

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THE PROBLEM FOR SURGERY IN THE TREATMENT OF MASSIVE HEMORRHAGE OF ULCER ORIGIN

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THE subject of bleeding from gastroduodenal ulcer has received considerable attention in the recent literature. A number of foreign and American authors have reviewed their experiences in dealing with massive hemorrhage and have importantly demonstrated that this complication of peptic ulceration carries with it a greater hazard than had commonly been conceded. At the present time medical gastroenterologists are greatly concerned with reducing mortality rates from hemorrhage. Many men interested in the problem have turned to new forms of treatment and in some clinics the old, well known, and time honored regimen commonly referred to as the "starvation treatment" has been replaced by newer procedures. Meulengracht (7, 8) has introduced the practice of feeding patients with hemorrhage rather than depriving them of food and water. He reports marked success by this method of management and has reduced the death rate in his patients to a low figure of 1.8 per cent. If his results could be obtained by others, the problem of decreasing mortality from bleeding would be solved in great part. Crohn, however, reports that he has not met with the same success using Meulengracht's treatment. Other new forms of medical therapy that have gained some prominence in the treatment of active bleeding from ulcer are the use of aluminum hydroxide preparations introduced into the stomach constantly by gastric intubation (10), and the so called massive transfusion method described by Marriott and Kekwick. At the present time it can be said safely that none of these new procedures has proved to be greatly superior to the older starvation plan of therapy.

Whether or not surgery shall take a prominent part in the immediate treatment of hemorrhage from ulcer is a debatable point and warrants serious consideration. Balfour (3), in summarizing the consensus of opinion held by most surgeons, advises against operation except under unusual circumstances. The factor of uncertainty of the diagnosis of ulcer in cases of massive bleeding is a not small consideration which increases the justifiable reluctance of surgeons to submit large numbers of patients to operation. Gradually, however, an increasing number of surgeons are advocating operative treatment for ulcer hemorrhage either as a measure for all patients in whom operation is possible or for selected groups. Finsterer has recommended early operation and believes that the best time for surgical intervention is within 48 hours after the beginning of hemorrhage. He reports reasonable mortality rates in the group of patients upon whom he has operated and he believes that in the use of surgery will be found the solution to mortality reduction for bleeding in patients with peptic ulcer. Gordon-Taylor, in England, and more recently Pfeiffer, in this country, have made pleas for a more active interest on the part of surgeons in the problem of massive hemorrhage. Surgeons must give careful attention to those who advise operative measures and must decide whether or not they will engage in a surgical program for the immediate treatment of bleeding. The surgical method of treatment has an attractive offer to make, since it proposes to stop bleeding completely and accurately. At the present time the indications for operation are not established, nor have the available reports on operative treatment clearly demonstrated that mortality can be reduced by surgery. While a plan for operative treatment on a large scale in massive hemorrhage cannot be accepted too enthusiastically, it cannot be rejected without careful study of the whole problem.

In order to estimate the seriousness of ulcer hemorrhage as it is seen in a general hospital,

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and to define the problem facing us, we have reviewed the records of patients with gastric or duodenal ulcer who have been treated for hemorrhage at the Albany Hospital during the past 9 years (1930 through 1938). In the hemorrhage group we included only those patients with either gastric or duodenal ulcer in whom there was definite bleeding of an acute nature with hematemesis, or tarry stools. The diagnosis of gastric or duodenal ulcer was substantiated by roentgenological examination in three-fourths of the patients in our series. In the other one-fourth no fluoroscopic examination of the gastro-intestinal tract was done. The diagnosis of these cases was accepted after careful appraisal of the clinical findings and course under treatment.

In all, there were 690 patients with peptic ulcer admitted to the Albany Hospital during the 9 year period of study. Duodenal ulcer was found to be four times more frequent than gastric ulcer. One hundred twenty-eight patients, or 18.6 per cent of the total 690, were admitted to the hospital because of bleeding. Hemorrhage was severe in two-thirds of the patients and mild in one-third. This classification was made on the basis of duration of bleeding episode, the severity of anemia, and the clinical condition of the patient. Only 17 of the 128 patients with hemorrhage proved to have gastric ulcer. In the 111 remaining patients, a diagnosis of duodenal ulcer was made. The incidence of bleeding among patients with gastric ulcer was found to be 11.6 per cent. In the case of those with duodenal ulcer, the hemorrhage incidence was 20.4 per cent.

There were 13 deaths among the 128 patients with ulcer hemorrhage, making a total mortality rate of 10.2 per cent. Except for 3 patients upon whom operation was performed to control hemorrhage, all were treated by a standard medical routine. At the Albany Hospital the conservative procedure has been one of preliminary starvation until obvious hemorrhage has ceased. Dehydration was combatted by intravenous and subcutaneous infusions of saline. After hemorrhage seemed to have stopped, various modifications of the Sippy dietary regimen were followed.

There were 125 patients treated in this general manner with 11 deaths in the group, making the mortality rate 8.8 per cent for patients treated by the conservative plan. We reviewed the clinical records of these 125 patients in an attempt to detect factors which might have some possible influence upon the gravity of hemorrhage. The duration of dyspeptic symptoms did not seem to have any bearing upon the mortality rate. A history of one or more previous hemorrhages was no more frequent among the patients who died than among those who survived. Of the 114 patients surviving 39.1 per cent had bled on one or more occasions before the present episode. Of the patients who died, 38.5 per cent gave a history of previous hemorrhage. The duration of hemorrhage before the patient came to the hospital varied widely but did not seem to have any direct bearing upon the mortality rate. It has been said that hemorrhage from ulcer among women is less serious than it is in men. Crohn encountered no deaths among the female patients whom he studied. There were 183 female patients with ulcer in our group comprised of 690 individuals. The incidence of hemorrhage among females was 14.2 per cent in contrast to a 20.1 per cent incidence in the males. The mortality rate among women was 7.7 per cent and among men was 10.8 per cent. The findings in our group would not seem to support the feeling that hemorrhage from ulcer in women is much less serious than in men. The mortality rate among patients with bleeding gastric ulcer was 35.3 per cent, a much higher figure than that found in those with bleeding duodenal ulcer (6.3 per cent). In this series it would seem that while the incidence of bleeding in cases with gastric ulcer is less than the incidence in duodenal ulcer, the mortality from hemorrhage is much greater. We found that previous surgical treatment seemed to protect the patient from fatal hemorrhage. Twenty-two patients, or 19.8 per cent of all patients with hemorrhage, had had posterior gastro-enterostomy performed previously. There were no deaths among these patients.

That age is an important factor in affecting mortality from ulcer hemorrhage has been emphasized by Allen and Benedict. In our investigation we have given the age factor particular study. After the age of 50, we found, as did

Allen and Benedict, that the incidence of death from hemorrhage abruptly increased. Of the 125 patients 75 were under the age of 50, and among these there was only 1 death, making the mortality rate 1.3 per cent. In the group beyond the age of 50, there were 50 patients and of these 10 died, producing a death rate of 20 per cent. Further analysis revealed that mortality increased with each decade of life beyond the age of 50. Although hemorrhage tended to be more prolonged and more serious in patients beyond the age of 50, it was not found to be a more frequent complication of ulcer as age advanced. We found no greater incidence of hemorrhage from ulcer in any given age period. The largest number of patients treated for ulcer and its complications were from 40 to 50 years of age. Among these individuals, however, the mortality rate was not high.

Postmortem examination was made upon all the patients who died from hemorrhage. It was found at autopsy that 6 of the 11 patients had a duodenal ulcer and in 5 there was a gastric ulcer. Of the 6 duodenal ulcers, 5 were found to be on the posterior wall and 1 on the anterior wall. Two of the 5 gastric ulcers were located on the posterior wall. Of the 3 others, one was situated on the lesser curvature, one on the anterior wall near the lesser curvature, and in the other there were multiple ulcers in the stomach and in the esophagus. Many of these ulcers were adherent to posterior structures, particularly the pancreas, and would have offered technical difficulties in removal. In one-half of the cases of single chronic ulcer, the pathologist was able to identify the bleeding point and in each case it proved to be an eroded arteriole. In no instance was erosion of the pancreaticoduodenal artery or other major vessel responsible for the bleeding. The incidence of cardiovascular disease was high in the patients who died. Coronary sclerosis and varying degrees of myocardial failure were present in 5 of these 11 patients.

An appraisal of the status of mortality from ulcer hemorrhage in the group of patients comprising our series has given us useful information which might prove most helpful to the surgeon considering the feasibility of a program of operative intervention for the treatment of massive bleeding from ulcer. In the first place, the record obtained in hemorrhage treatment by conservative medical management offers tremendous competition for surgery and has set a rather high standard. A total mortality rate of 8.8 per cent charged to conservative management is a formidable figure for surgeons to improve if they are to assume responsibility for all deaths from hemorrhage. Secondly, we feel that it is doubtful that the patient with severe hemorrhage from ulcer which will prove fatal can be reliably separated and singled out for operative interference. On the other hand, several important helpful statements can be made, based upon the fact that the age of the patient is the most important factor affecting the outcome of a bleeding episode. It is probably safe to say that surgery has little or no place in the treatment of hemorrhage in the younger patient. Patients under 50 years of age have an excellent prognosis for recovery from a given hemorrhage under medical management. In our series the mortality was under 2 per cent. The younger individual may repeatedly appear to be near death and recover during a serious prolonged episode of bleeding. Surgery done in desperation under these circumstances is probably not advisable and we believe that the patients' chances for survival are better with expectant treatment. Operative interference in this group might result in raising the mortality rate rather than lowering it. In the patient beyond the age of 50, the situation is different. In this group there was a 20 per cent mortality rate which offers an opportunity for improvement. It is possible that surgery has its place in the treatment of hemorrhage in the patient of advanced years. To what extent it should be used and upon which patients in this group operation should be performed, we could not determine from this study. We do know that many of these elderly patients are in poor physical condition when admitted to the hospital and that a certain number cannot be operated upon. If the surgical procedures necessary for arresting hemorrhage were simple and easily performed in a short period of time, there might be less hesitancy to recommend surgery on a large scale in this group. An adequate operation for controlling bleed-

ing from an ulcer, however, usually demands that the ulcer be resected. The experiences of many surgeons have shown that ligation of the blood supply to any portion of the stomach or duodenum is an unreliable and usually a futile procedure. Likewise, gastro-enterostomy and jejunostomy are inadequate for the most part and cannot be expected to stop bleeding. Resection of the ulcer may demand considerable time consuming operative work and necessitates in many instances further operation for restoring gastro-intestinal continuity. Most frequently the surgeon will find a duodenal ulcer on the posterior wall, the removal of which will require partial gastric resection. Operations which are questionably adequate for stopping bleeding can only do harm to the patient since they submit him to a risk of his life without giving the security that hemorrhage is controlled.

Reports of large series of cases in which patients were operated upon for hemorrhage cannot be accepted enthusiastically unless they show a reduction in mortality for the age groups from which the patients are taken. Inclusion of a large number of younger individuals in a group subjected to operation will lower operative mortality rates without necessarily improving the mortality rate in general. We believe that estimations of surgical results in reducing mortality from ulcer hemorrhage will be valid when they are made with reference to the accomplishments attained in reducing mortality among the patients in the various age groups. Before embarking upon a program for surgical intervention in the treatment of massive hemorrhage in patients with gastroduodenal ulcer, the surgeon must accept the fact that the field for improvement in mortality is among those patients beyond 50 years of age. The situation at hand is one which calls for the use of operative procedures of considerable magnitude to be performed upon patients in the sixth, seventh, and eighth decades of life, who are frequently poor risks for surgery.

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THE SIGNIFICANCE OF NUTRITION AND GASTRIC ACIDITY IN THE ETIOLOGY OF EXPERIMENTAL PEPTIC ULCER

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IN 1923, Mann and Williamson described a method for the experimental production of peptic ulcer in dogs. This procedure is essentially an operation which changes the position of the duodenum so that its contents drain into the distal ileum instead of the beginning of the jejunum. The operation (Fig. 1) is performed first by section through the pyloric ring and blind closure of the proximal end of the duodenum. Then the terminal part of the duodenum is cut across at the ligament of Treitz, and anastomosed to the ileum at a point 40 centimeters proximal to the cecum. Finally, the pyloric end of the stomach is anastomosed to the beginning of the jejunum, where the latter has been severed from the duodenum. Practically every animal surviving such an operation will die of a jejunal ulcer within 90 days.

Mann-Williamson preparations manifest a declining state of nutrition from the day of the operation until death supervenes. This condition is evident by the occurrence of weight loss, anorexia, weakness, and anemia. The rôle of gastric acidity as the etiological factor responsible for ulcerations of the susceptible jejunal mucosa, has been the focus of much attention, whereas the relationship of these lesions to the poor nutritional state has been quite overlooked. Neither has any significant investigation been made into the actual effect of the Mann-Williamson operation upon gastric acidity. The little data available through the work of Weiss and Hubster, Morton, and McCann reveals no appreciable change.

The object of this study was to determine the effect of the Mann-Williamson type of operation upon gastric acidity, and to evaluate the respective parts played by postoperative gastric acidity and nutrition in the etiology of the ulcers following such operations.

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METHODS

1. In order to study the relationship of gastric acidity and nutrition to the occurrence of jejunal ulcer in Mann-Williamson preparations, it was found necessary to devise modifications of the original operation. It was decided to submit the dogs first to a first stage operation (see b, Fig. 2) which varies from the Mann-Williamson procedure in that the distal end of the duodenum is anastomosed to the small intestine at a point 120 centimeters distal to the gastrojejunal anastomosis instead of 40 centimeters proximal to the cecum. This change increases the distance between the cecum and the influx of duodenal juices and thus provides a more adequate nutritive state than the original Mann-Williamson operation because much more of the small bowel is exposed to the important digestive action of the biliary and pancreatic juices coming by way of the duodenum. The region of the gastrojejunal anastomosis is anatomically and physiologically the same as in the Mann-Williamson procedure, and so an excellent preparation is available to study the gastric acidity factor.

Twenty-eight healthy dogs of mongrel breed and varying weights were placed on a stock diet and permitted to become acclimated to laboratory conditions for 2 weeks. Following this period, fractional gastric analyses were performed on each dog at weekly intervals until 10 determinations had been made. One hundred twenty cubic centimeters of 7 per cent alcohol was used for the test meal. The alcohol was introduced by stomach tube, and samples were aspirated every half hour for 2 hours. Fractional gastric analyses were also made to obtain the response to 1 milligram of histamine injected subcutaneously. The con-

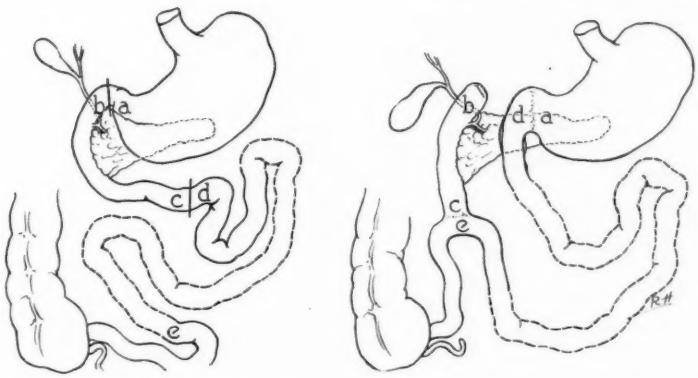

Fig. 1. The Mann-Williamson operation. Note that the distance from the ileocecal junction to *e* equals 40 centimeters.

trol values having thus been established, the dogs were subjected to the first stage operation.

2. The animals surviving this operation were studied for gastric secretion with alcohol test meals and histamine for 13 weeks, or until death intervened. In those animals still alive, jejunal ulcer was ruled out by making an incision into the pyloric antrum, inserting a small proctoscope and directly inspecting the jejunal mucosa. Then the second stage operation was performed. In this procedure, a segment of intestine between the duodeno-ileostomy and the cecum was resected so that only 40 centimeters of ileum was left between these two points (see c, Fig. 2). The segment was converted into a Thiry loop, that is, the proximal end was closed blind and the distal end brought out through a stab-wound in the abdominal wall. In this preparation, the gastric acidity factor has not been altered; but decreasing the length of intestine between the duodeno-ileostomy and the cecum to 40 centimeters (same as in true Mann-Williamson operation) has reduced the nutritional factor by decreasing the amount of intestine exposed to the action of the biliary and pancreatic juices.

3. The animals which did not die of ulcer following the second stage operation were subjected to the third stage operation. This procedure consisted of simply restoring the Thiry loop back into its original position to convert the animal into a first stage preparation. It was hoped this would improve the animal's nutritional condition and save its life.

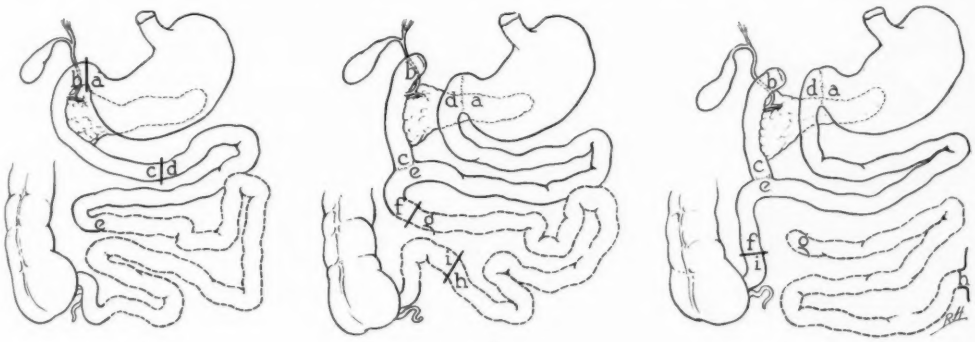

Fig. 2. a, Normal. b, First stage operation. Note that the distance from gastrojejunal anastomosis *ad* to *e* equals 120 centimeters. c, Second stage operation. Note that the distance from *e* to ileocecal unction equals 40 centimeters.

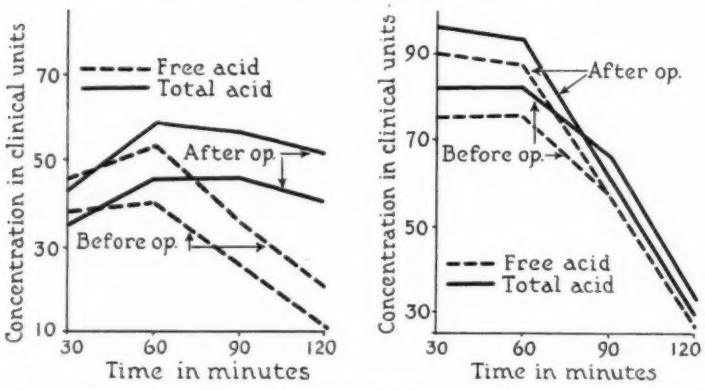

Fig. 3. a, left. Graph of gastric secretory response to alcohol test meal in 24 animals before and after first stage operation. b, Graph of gastric secretory response to injection of 1 milligram of histamine in 24 animals before and after first stage operation.

TABLE I.—OBSERVATIONS ON THE 24 DOGS SURVIVING FIRST STAGE OPERATION

Dog no.	Weight lbs.	Time observed days	Final weight lbs.	Weight gain per cent	Weight loss per cent	Gastric secretory change*	Ulcer	Remarks
225	23	359	20¾		9.8	I	O	
226	32¾	342	36½	11.5		I	O	
227	26½	353	30	13.2		U	O	
228	34¾	112	21¾		36.5	I	Yes	Perforated ulcer
229	22	63	17½		20.5	I	Yes	Perforated ulcer
230	25½	77	25½	0	0	D	Yes	Shallow ulcer
231	25¾	236	20		20.8	I	Yes	Shallow ulcer
232	21½	330	24	11.6		I	O	
233	31½	131	25½		19.1	I	Yes	Perforated ulcer
234	31½	23	27½		12.7	?	Yes	Perforated ulcer
235	24¾	331	23		7.1	I	O	
236	32½	318	34	4.6		I	O	
237	34	331	41¾	22.8		I	O	
239	23¾	321	19½		18.0	I	O	
242	39	133	33¾		13.5	U	Yes	Perforated ulcer
243	35	151	22½		35.7	U	O	Moderate jejunitis
245	30¼	164	15¼		50.0	I	Yes	Chronic ulcer
246	27	311	23¼		13.9	I	Yes	Chronic ulcer
247	21¼	139	14		32.9	I	Yes	Shallow ulcer
248	21¼	306	20		5.9	I	O	
249	28	304	23½		23.2	I	Yes	Perforated ulcer
252	22¼	161	23½	5.6		U	O	
253	23½	307	25¼	7.4		I	O	
254	26½	298	22		17.0	I	Yes	Chronic ulcer

*I—Increase D—Decrease U—Unchanged

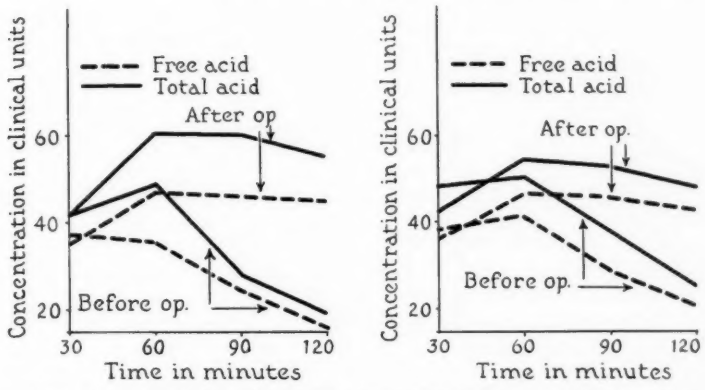

Fig. 4. a, left. Graph of gastric secretory response to alcohol test meal before and after first stage operation in 12 animals not developing ulcer after operation. b, Graph of gastric secretory response to alcohol test meal before and after first stage operation in 12 animals developing ulcer after operation.

RESULTS

Twenty-four animals survived the first stage operation. The gastric secretory response to an alcohol test meal before and after the operation was averaged for all these animals, and the results transposed into concentrations in clinical units. A graph was drawn (a, Fig. 3) which shows the curves for both free and total acid values before and after the operation. These curves show that after operation there is a marked increase in the acidity of the gastric juice with an alteration in the type of curve. After the operation, there is a tendency to continued secretion at a high level, whereas the control values show a marked drop by the end of the secretory period.

The curves obtained by the gastric secretory response to histamine show a similar change (b, Fig. 3). This indicates that the increased acidity of the gastric juice after the first stage operation was not due to alteration in ability of the gastric glands to secrete acid juice.

Table I indicates the weight changes, gastric secretory changes, and the incidence of ulcer formation in the 24 dogs surviving the first stage operation. It is noted that 12 animals developed jejunal ulcer in an average time of 154 days with an average weight loss of 21 per cent. Eleven animals with an average weight gain of 3.2 per cent had no ulcers (proved at second stage operation), and 1 animal died without an ulcer in 151 days.

TABLE II.—OBSERVATIONS ON 10 ANIMALS SURVIVING SECOND STAGE OPERATION

Dog no.	Weight lbs.	Time observed days	Final weight lbs.	Weight loss per cent	Ulcer	Remarks
225	20¾	189	15½	25.3	O	Still living
226	36½	32	27	24.0	O	Died of intussusception of blind intestinal loop
227	30	104	20	33.3	O	Intussusception
232	24	13	18½	21.9	O	Intussusception
235	23	53	18¼	20.7	Yes	Penetrating jejunal ulcer
236	34	58	21	38.2	Yes	Penetrating jejunal ulcer
237	41¾	188	27	35.4	O	Still living
239	19½	62	14¾	23.1	Yes	Penetrating jejunal ulcer
248	20	52	12½	37.5	Yes	Shallow jejunal ulcer
253	25½	56	17	32.7	Yes	Penetrating jejunal ulcer

It is known that almost 100 per cent of true Mann-Williamson preparations will die of ulcer within 90 days. As has been previously explained, the first stage animal differs from the Mann-Williamson preparation only in that it has a larger amount of intestinal surface exposed to the action of the biliary and pancreatic juices. It follows, therefore, that increasing the digestive surface decreases the incidence of ulcers and prolongs the time necessary for them to form.

The gastric secretory response to an alcohol test meal in both the dogs developing ulcer after the first stage operation and those which did not, were respectively averaged and transposed into units of clinical concentration. Graphs were drawn (a and b, Fig. 4) plotting the pre-operative and postoperative acidities (free and total) in both groups of dogs. It is readily seen that almost identical curves are present in the animals which developed ulcers and those which did not. This indicates that there is no relationship between postoperative acidity levels and the incidence of jejunal ulcer.

A study of the individual gastric secretory curves revealed that of 11 dogs developing ulcers subsequent to the first stage operation in which pre-operative and postoperative data are available, 7 showed a significant increase in acidity. The gastric acidities of these animals showed a concentration of 50 clinical units or more. This does not indicate a greater tendency toward ulcer formation in dogs with high postoperative acidity because in the 11 dogs which did not develop ulcer, a concentration of 50 clinical units or more was reached in 7 instances.

Ten dogs survived the second stage operation. Table II reveals that 5 of these animals developed ulcer in an average time of 56 days with an average weight loss of 29.2 per cent, 3 died of intussusception, and 2 dogs are still living, and apparently will not develop ulcer. It is evident that in dogs with a high internal duodenal drainage, jejunal regurgitation could not be the factor that protects the gastrojejunal area from ulceration, because resection of a large segment of intestine distal to the duodenoenterostomy results in jejunal ulcers. These lesions, occurring after a procedure which only decreases the total amount of intestinal digestive surface, indicate that the rôle of nutritional disturbance is extremely important in the etiology of gastrojejunal ulcer.

Of the 5 animals developing ulcer after the second stage operation, only 2 lived long enough to have a third stage operation. This procedure failed to prolong their lives; the animals died shortly after the operation.

CONCLUSIONS

1. When the duodenum of the dog is resected from its gastric and jejunal extremities and a gastrojejunal anastomosis is performed, it is observed that the incidence of jejunal ulcer subsequent to drainage of the duodenum into the small intestine is decreased if the point of drainage is placed closer to the site of the gastrojejunal anastomosis. In other words, the higher the site of internal duodenal drainage, the smaller the incidence of ulcers. The time necessary to produce the ulcer is also lengthened.

2. The gastric acidity response to an alcohol test meal and histamine is increased after operations of this duodenal drainage type.

3. There is no relationship between postoperative acidity levels and the incidence of jejunal ulcer.

4. The importance of malnutrition in the development of experimental jejunal ulcer is indicated by the fact that dogs which maintained nutrition and even gained weight after a high duodenal drainage operation, developed ulcers after nutrition was impaired by a resection of considerable small intestine between the point of drainage and the cecum.

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THE RELATION OF CHRONIC CYSTIC MASTITIS TO MALIGNANCY

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THE breast, like the endometrium, is constantly undergoing periodic changes of progression and regression (hyperplasia and involution) from birth to senility. Except for a few periods during life, the histological picture is changed weekly if not daily. It is for this reason that a knowledge of the anatomy and physiology of the organ is essential to a correct understanding of its various pathological processes.

The breasts are covered by the superficial fascia of the anterior thoracic region. From the deeper layers of this fascia, septa proceed inward which divide each mamma into from 15 to 20 lobes which are further divided into many lobules by a continuation of the connective tissue from the parent lobar septa. The parenchyma of the gland is composed of two main structures, specialized connective tissue on the one hand and duct and acinous epithelium on the other. The acini are cluster-like dilatations from the walls of the lactiferous ducts. These ducts are lined with low cuboidal epithelium and are surrounded by a layer of smooth muscle cells supported by the membrana propia. The terminal lactiferous ducts are composed of simple cuboidal epithelium supported by a delicate stratum of muscle. It is by junction of these small ducts from the many lobules that the excretory duct of the lobe is formed. Here the epithelial cells have become taller (columnar) and surrounded by smooth muscle, subepithelial connective tissue (6), elastica, the second layer of smooth muscle and the pericanalicular connective tissue. Each excretory duct enlarges near its termination to form an ampulla. Just beyond the ampulla the epithelium changes from columnar into transitional epithelium which is continuous with the stratified squamous epithelium which covers the nipple.

It is evident that the breast, like the uterus, is under the direct control of the ovary, and the ovary in turn is under the control of the anterior pituitary. The ovary exerts a dual hormonal influence on the breast, the peri-acinous and periductal connective tissue being governed by the follicular and interstitial parts of the ovary while the duct and acinous epithelium are under the control of the corpus luteum. If this control becomes abnormal by a disturbance in the time or volume of hormonal liberation, the periodic mammary changes may cross the borderline from the physiological into a pathological state (6).

In the newborn relatively few ducts and practically no acini are present (Fig. 1). The periductal connective tissue is scant and lymphocytes may be seen in certain areas. As a result of the presence in the blood of the female sex hormone, epithelial proliferation may be marked and may even resemble the activity of lactation. Shortly after birth the breast enters a dormant period due to the disappearance of the female sex hormone.

At puberty, as a result of ovarian activity, the mammary gland takes on new life (Fig. 2). Budding takes place, new ducts are formed and new acini develop. At times there is dilatation of the ducts and colostrum and desquamated epithelium may be seen in their lumina. Hyperplasia of the pericanalicular and periacinous connective tissue is present with lymphocytic infiltration into these specialized connective tissue elements.

With the establishment of menstruation the breast undergoes cyclic changes as a result of ovarian stimulation.

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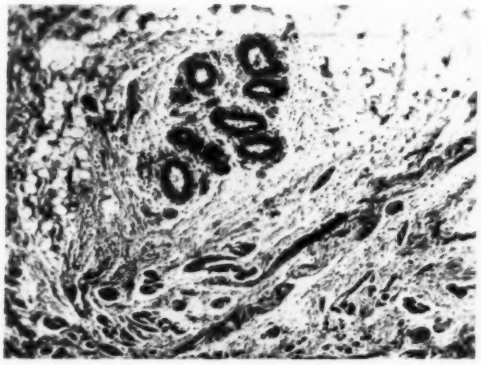

Fig. 1. Breast of newborn. In this section is seen a group of ducts which are surrounded by scant connective tissue.

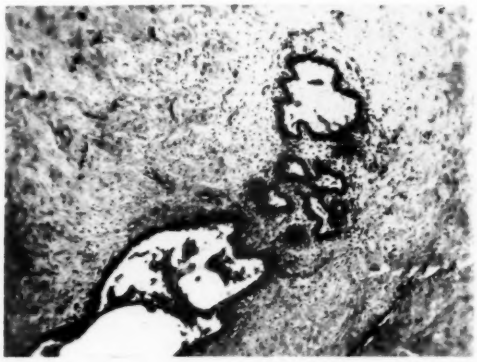

Fig. 2. Breast at puberty. There is marked dilatation of the duct with colostrum in the lumen. Hyperplasia of the pericanalicular connective tissue is evident.

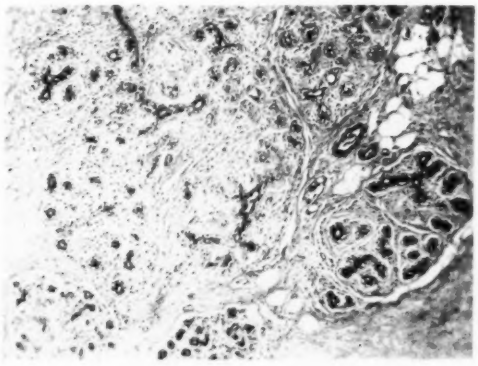

Fig. 3. Postmenstrual breast. The entire picture is one of inactivity: the ducts are small, the epithelium low and dry, connective tissue bands are prominent.

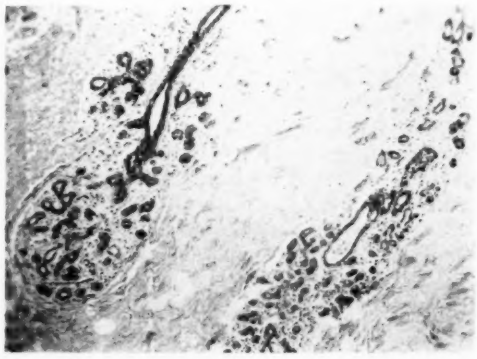

Fig. 4. Premenstrual breast. There is budding and new duct formation. The epithelium is active and round cells are present.

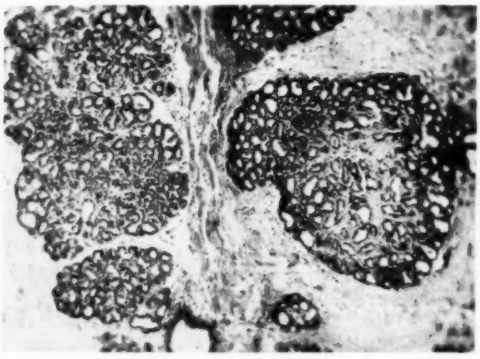

Fig. 5. Breast during pregnancy. X40.

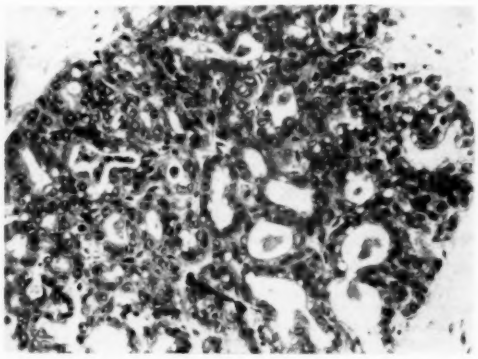

Fig. 6. Breast during pregnancy. X160.

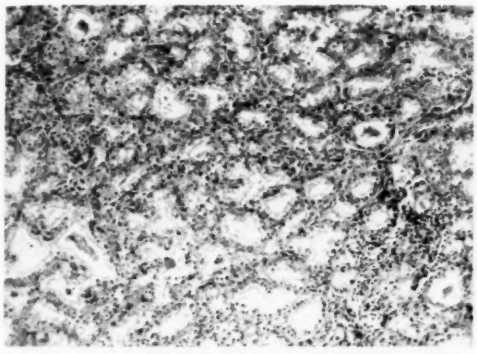

Fig. 7. Lactation. Fat and connective tissue have been replaced by ducts and acini. The epithelial cells show different degrees of secretory activity.

Fig. 8. Involution. In this section there is found general atrophy and disappearance of the new ducts and of the acini.

Fig. 9. Periductal fibroadenoma. Small groups of ducts surrounded by much pericanalicular connective tissue.

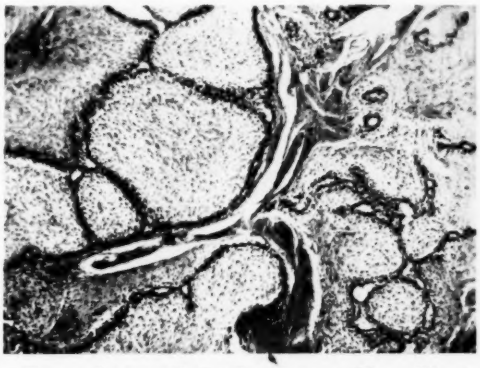

Fig. 10. Intracanalicular fibroadenoma. The proliferating connective tissue has invaginated the duct.

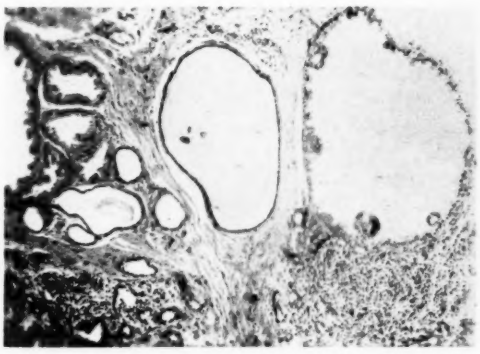

Fig. 11. Adenosis. Dilated ducts, epithelial hyperplasia and papillomas.

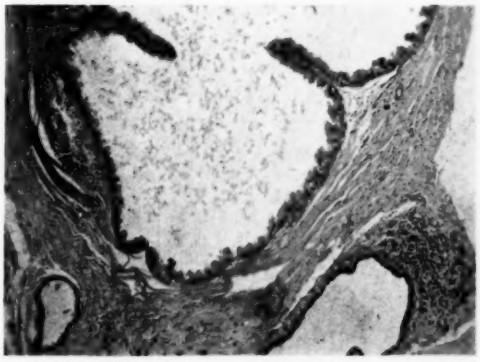

Fig. 12. This section shows cyst containing intraductal papilloma.

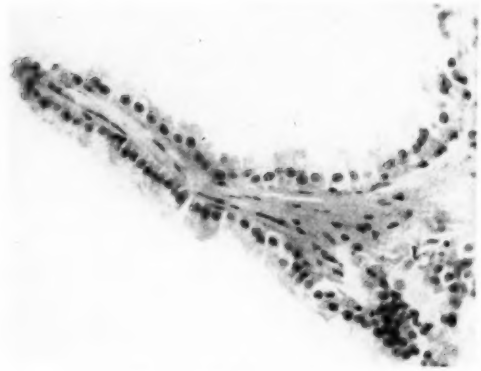

Fig. 13. Papilloma. ×160.

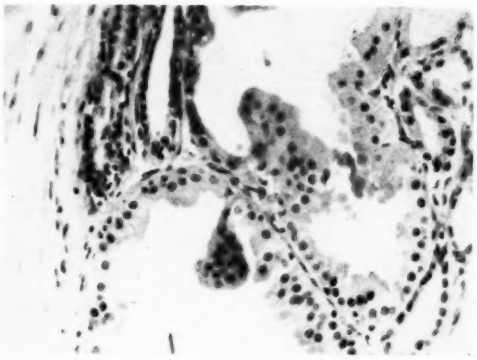

Fig. 14. Adherent papilloma.

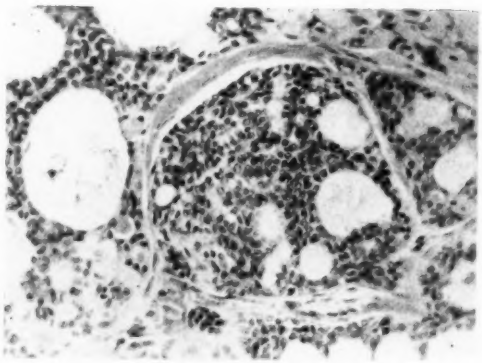

Fig. 15. Benign comedo adenoma.

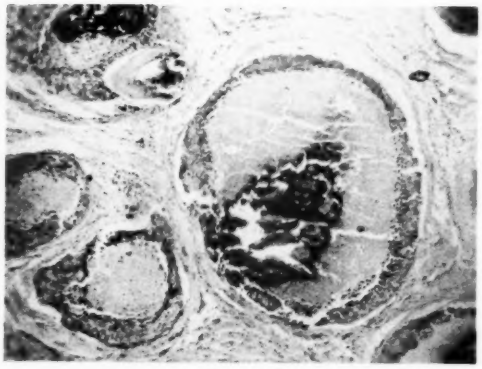

Fig. 16. Intraduct carcinoma.

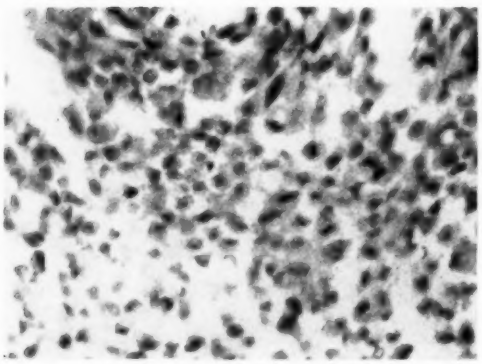

Fig. 17. Intraduct carcinoma. ×160.

In the usual virginal breast for 10 days immediately following menstruation one observes a regressive stage in mammary activity (Fig. 3). The epithelium of the ducts is quiescent and inactive and the acini are rudimentary or absent. The periacinous and periductal connective tissue is active and sharply demarcates the lobules from the surrounding supportive tissue. Lymphocytes may be seen scattered throughout the specialized connective tissue.

After ovulation on the fourteenth or fifteenth day of the menstrual cycle, the corpus luteum forms and the breast enters the proliferative stage (Fig. 4). The specialized connective tissue "softens and becomes myxomatous to

allow for gland expansion" (5). The epithelium is active and piles up in the dilated lumina of the ducts. Vacuoles develop in the cytoplasm and the ducts show marked budding. Round cells continue to invade the connective tissue. Secretion appears in many ducts and this completes the picture often seen in the swollen, tender breasts commonly preceding menstruation. The activity of the glandular epithelium and connective tissue is always in preparation for pregnancy just as the secretory phase of the endometrium is a preparation for nidation of the ovum. If the ovum is fertilized and gestation progresses, the cuboidal epithelium lining the acini undergoes a process of fatty degeneration to form first colostrum and then milk. If the ovum is not fertilized, the breast returns to the resting condition by a process of degeneration similar to that of the endometrium. The duct and acinous epithelium degenerates, is shed into the lumen, and the cell débris is eliminated by the action of mononuclear phagocytes.

During pregnancy the breast undergoes its greatest physiological change (Figs. 5 and 6). Under the influence of the corpus luteum of pregnancy the epithelium grows at the expense of the connective tissue. Many new acini are formed from the budding ducts and the fat is replaced by the abundant epithelial tissue. Immediate secretory activity is probably delayed by the antagonistic action of the placenta.

When the fetus is delivered and the placenta discharged, the inhibitory agent is no longer present and the proliferative stage gives way to the secretory or the *stage of lactation* (Fig. 7). Microscopically the lactating breast is uniform in appearance, the fat and specialized connective tissue are replaced by enormous growth of ducts and acini. The lobules are enlarged, the epithelium is hypertrophied, and the glands show different degrees of secretory activity.

When lactation ceases, the breast enters into a state of *involution* (Fig. 8). There is general atrophy and disappearance of the new ducts and acini, but here and there both ducts and acini may remain. The returning connecting tissue undergoes hypertrophy and the breast never completely returns to its former state. Certain parts will show epithelial and connective tissue atrophy resembling that seen in the regressive stage in the virgin; while in other areas there is hypertrophy of the specialized connective tissue with round cell infiltration and desquamation of epithelium into the terminal ducts. This is the mazoplasia of Cheatle and Cutler and should not be confused with chronic mastitis for "the function of the mononuclear cells is to remove the products of secretory activity and clean up the cell débris" (5). This is merely normal phagocytic activity and should not be confused with infection.

Not infrequently the terminal ducts remain distended with accumulation of dead epithelial cells therein and the case is erroneously labeled chronic cystic mastitis. This also is a part of the mazoplasia of Cheatle and Cutler and should not be confused with a true pathological process. "Mazoplasia is present in nearly all women between 30 years of age and the menopause and disappears with the advent of the latter. It is characterized by diffuse pain over one or both breasts, which is aggravated by menstruation and movement of the upper extremities. There is a fine nodularity present in non-fatty breasts, and menstruation is short and scanty. The condition occasionally disappears spontaneously or during pregnancy."

As previously stated, the breast is continuously undergoing changes of progression and regression as a result of hormone stimulation. Since the endocrine life of the individual is different during the various decades, it is logical to assume that pathological change will bear a close relationship to the various decades of life. Such is the case.

During the first decade of menstrual life two common pathological changes occur in the breast. These are periductal and intracanalicular fibroadenomas (Figs. 9 and 10) and are probably the result of over hormone stimulation or endocrine hypersensitivity on the part of certain tissues. In the former, small groups of ducts possessing inactive epithelium and surrounded by a large amount of pericanalicular connective tissue are seen. In the latter, the ducts have been invaginated by the proliferating connective tissue.

During the second decade of menstrual life the border line between the physiological and pathological is frequently crossed and "chronic cystic mastitis" develops. The term "chronic cystic mastitis" covers a wide range of altered physiological and pathological processes. Its use is misleading and a clear understanding of the processes involved has been made difficult by the multitude of names by which it has been called. It includes the swiss cheese type of cystic disease described by Reclus in 1883 and designated by his name. It also includes a non-encapsulated papillary cystadenomatous condition of the breast described 23 years later by Schimmelbusch and called Schimmelbusch disease. To these may be added the fibroadenomatosis cystica of Semb and the Cobblestone breast of Warren. The condition is also frequently designated as shotty breast or simply as benign cystic disease. Bloodgood made extensive studies and labeled the condition senile parenchymatous hypertrophy and insisted that the condition was not precancerous. Cheatle and Cutler have contributed the title cystipherous desquamative epithelial hyperplasia and Lewis and Geschickter (12) have recently divided the condition into adenosis and cystic disease. Boyd's name of cystic hyperplasia is a practical one.

The various changes that take place are probably the result of ovarian stimulation, but Adair and others believe them to be the result of inadequate duct drainage and stagnation resulting in irritation and stimulation. The changes may take place locally in one system of ducts or lobe of the breast and be recognized by its triangular shape with apex near the nipple and base toward the periphery. One hemisphere, the entire breast, or both breasts may be involved. In contrast to the first decade of menstrual life, it is the epithelium which is involved here instead of the connective tissue. This altered physiology results in the production of chronic cystic mastitis and the bluedome cyst of Bloodgood.

If adenosis (the cystipherous desquamative epithelial hyperplasia with neoplasia of Cheatle and Cutler) is the predominating feature (Fig. 11), microscopic examination of the area reveals epithelial proliferation with the formation of small intracystic papillomas or non-encapsulated adenomatous areas. The cystic disease may be characterized by the formation of one or several well developed cysts, the so called bluedome cyst of Bloodgood. The lining epithelium is flattened from intracystic pressure, and Bloodgood contended that these lesions had no relationship to malignancy. However, if one sections the entire gland, dilated ducts containing intraductal papillomas are frequently observed and these not infrequently show the presence of malignant change (Fig. 12).

In the third decade of menstrual life certain breasts fail to cease activity with cystic hyperplasia and go on to benign neoplasia, and possibly carcinoma. The active epithelium is laid down layer by layer to form sessile papillomas. In other instances connective tissue stalks invade the epithelial growths and true papillomas are formed (Fig. 13).

At times the multiple papillomas attach themselves one to the other to form new gland surfaces and adenomatous masses (Fig. 14). These are the so called comedo adenomas of Bloodgood (Fig. 15). When sectioned at the operating table, pinhead or pinpoint sized ducts are seen, which upon pressure send forth worm-like masses of yellow (comedones), caseous material. Bloodgood insisted that these adenomas were all benign. We are unable wholly to support this view. Our series of cases have proved to our satisfaction the existence of both benign intraduct adenomas and various degrees of malignancy in duct carcinoma (Figs. 16 and 17).

In cases that were microscopically malignant, our records show both success and failure following the same technique of complete operation and deep roentgen therapy. Cutler has shown cyst papilloma and carcinoma in the same duct and sets forth evidence that 20 per cent of all carcinomas of the breast have their origin in cystipherous desquamative epithelial hyperplasia.

The evidence at hand seems to favor the idea that the greater number of pathological changes in the breast are hormonal in origin. As previously stated, experimental investigation has established the dependency of mammary connective tissue development upon the follicular hormone and of epithelial tissue ac-

tivity upon the corpus luteum. If one accepts this relationship between ovarian secretion and mammary activity, it is easy to visualize a disturbance in this delicate balance with resulting disturbances in hyperplasia and involution. In many cases the fault may lie in the anterior pituitary since this gland is the dynamic motor activator of the ovary.

To a group of patients complaining of pain, tenderness, induration or nodularity of the breast, we are administering the estrogenic hormone (progynon) with promising results. Hormonal therapy is directed toward counterbalancing the effect of the corpus luteum in order to bring about involution in the glands. Ten thousand international units are given the first week in the menstrual cycle. The same dose is repeated the second week and twenty thousand units are given the third week. This course of treatment is followed by the administration of ten thousand units each third week thereafter.

The patient rarely calls attention to induration and fine nodularity of the breast, but is greatly concerned, and properly so, when a solitary mass appears. When the latter occurs, hormone treatment should never be instituted and expectant treatment has no place in the management. In our clinic each patient is prepared as for radical operation and the tumor removed, the excision being done in such a manner as to include a wide margin of normal breast tissue. The operator bisects the tumor for macroscopic inspection and turns it over to the pathologist, who is always present at the operation. Immediate frozen sections are made and if upon microscopic examination the lesion is found to be benign, the wound is closed; the operator changing gloves and instruments in every case after bisecting the tumor. If the microscopic examination reveals a malignant tumor, the radical operation is done at once and adequate deep roentgen therapy is given. A register is kept of all cases and the gross specimen and microscopic slides are preserved along with the case history for future reference.

A close association between surgeon and pathologist is a great help in the diagnosis and management of mammary disease. We believe that the adoption of this or a similar plan in the management of all breast cases will aid in the accuracy of diagnosis and the elimination of unnecessary operations. Furthermore, a step toward the prevention of carcinoma will be taken by the early and wide removal of pathological lesions. Life may be saved by thorough study of the pathological change in each patient at time of local removal, to be followed immediately by complete operation when pathologist and operator agree upon malignancy.

CONCLUSIONS

The problem of interpreting the pathology and the management of so called chronic cystic mastitis is yet unsolved. The multitude of names applied are confusing and an effort has been made to clarify this. Many authors using the common name feel that it is unsatisfactory, including as it does borderline condition between the physiological and pathological, as well as benign tumor masses and malignant hyperplasia.

The persistently high mortality rate in treatment of cancer of the breast, 50 to 65 per cent, in spite of the standardized operative and irradiation techniques, calls for intensive study and prophylactic steps. The treatment of certain early stages or forerunners of chronic cystic mastitis with hormones, is a step in the proper direction and may lead us into a beneficial prophylactic field.

We feel that it is the duty of the obstetrician to instruct patients about the care of the breast as well as of the uterus. We also feel that the gynecologist and surgeon should join hands with the pathologist in the operating room and laboratory, in order to reach a more accurate diagnosis and through it institute the most efficient and satisfactory treatment.

We desire to express our appreciation to Dr. Charles F. Geschickter for the privilege of studying in the surgical pathological laboratory of Johns Hopkins Hospital and for suggestions and loan of material.

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CLINICAL SURGERY

FROM ST. VINCENT'S AND THE ROYAL NORTH SHORE HOSPITALS, SYDNEY

OPERATIONS FOR GALL STONES

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ALTHOUGH the surgical treatment of gall stones has been established for many years, there is still considerable divergence of opinion concerning many technical details and the indications for operation in acute cases. The extent of the operation is largely determined by the character and site of the gall stones and the pathological conditions found when the abdomen has been opened.

PREPARATION OF PATIENT

A thorough investigation of the patient is made and the usual general and local preparation for operation carried out. No aperients are given less than 36 hours before operation. An enema is usually given the night before and not less than 4 to 6 hours before operation. Intramuscular injections of colloidal calcium (0.5 cubic centimeter) should be given on the eve and on the morning of the operation to jaundiced patients or others who may have a tendency to hemorrhage. If the Quick test shows that prothrombin is decreased, vitamin K and bile salts should be given.

ANESTHESIA

A well administered anesthetic is of primary importance and should provide freedom from oozing and good relaxation. While general, local, or spinal anesthesia may be used, one of the general anesthetics is preferred; of these, ether appears to be the best and to give greater relaxation and less tendency to bleeding than the other inhalation anesthetics. Atropine should be given as a routine before operation. The skill and experience of the anesthetist are probably of greater importance than the anesthetizing agent. Bad anesthesia may make a simple procedure extremely difficult and the more postoperative vomiting that occurs the greater the liability to an incisional hernia.

CHOLECYSTECTOMY

Indications. The gall bladder should be removed whenever possible if gall stones are present, also after choledochotomy when it is certain that the common bile duct is clear. Removal is contra-indicated in those acute and subsiding cases in which there is a thick, brawny infiltration with shortening of the mesentery of the cystic duct, and in most cases in which, during operation, satisfactory exposure of the region of the cystic duct cannot be obtained.

Incision. The upper right rectus paramedian incision is employed almost invariably and is preferred to the Kocher and other incisions. Before the incision is made 3 or 4 superficial scratches are made in the skin with the point of the knife drawn backward horizontally across the proposed line of incision at the levels in which it is intended later to insert the deep skin sutures (Fig. 1). The incision itself should be from 4 to 6 inches in length. As soon as the rectus sheath is exposed, the drawing of the end of the handle of the scalpel along it in the line of the incision bares the anterior wall of the sheath sufficiently to facilitate the incision into it.

The rectus sheath should be opened vertically in its inner third, preferably about ⅛ to ¼ inch to the right of the medial border of the rectus, a little more than sufficient of the sheath being left to hold the suture. In this way most of the rectus muscle is left undisturbed in its attachments and its relations to the anterior wall of the rectus sheath, and less bleeding is encountered from vessels in the muscle. The muscle is carefully dissected from the anterior sheath of the rectus medial to the incision, where it is firmly attached along the lineæ transversæ, and retracted to the right. The peritoneum is opened vertically, about ½ inch lateral to the incision in the rectus sheath, so that the line of suture of the peritoneum will lie immediately behind the middle of the rectus muscle and lateral to the incision in its anterior sheath. Side towels are placed in position and a moist pack is placed in the abdomen. A four-bladed, self-retaining abdominal retractor gives better exposure through a shorter incision and an immobile field.

General examination of the abdomen. The hand is now passed carefully into the wound beneath the liver and a preliminary examination of the region of the gall bladder is made. Except in the presence of acute disease of the gall bladder, dense abdominal adhesions, or other contraindications, all abdominal viscera are then systematically and rapidly examined in order to detect any abnormal condition.

The next step in the operation is the examination of the liver, gall bladder, and bile ducts. A moist pack is placed above the colon and the left hand of the first assistant retracts the intestines from the under surface of the liver (Fig. 2). When properly retracted, the right free edge of the lesser omentum should be taut and about half an inch in front of the posterior abdominal wall.

The gall bladder is examined and palpated for gall stones and its pathological condition is noted. The presence of adhesions is determined and particular attention is paid to the pathological condition of the tissues in the region of the cystic duct.

When adhesions are present, they can in the majority of cases be stripped very readily from the gall bladder as far as the common duct by a gauze swab on a sponge-holding forceps. Adhesions which are the accompaniment of an acute inflammation of the gall bladder can often be stripped easily. Thicker adhesions are usually the result of previous attacks and adhesions following a previous cholecystostomy are usually very thick and extensive, while thick adhesions to the colon, stomach, or duodenum may be associated with a fistula between the gall bladder and these organs. At times a distended Hartmann's pouch of the gall bladder may be found adherent to the common duct but can usually be separated with ease. Adhesions to the liver, at one or both sides of the gall bladder, are not uncommon; if they are at all firm or do not strip readily, they must be carefully tied and divided. Failure to take this precaution may result in the stripping of a portion of the capsule of the liver and cause troublesome bleeding.

When the gall bladder and right free edge of the lesser omentum have been displayed, the assistant removes his left hand and a careful examination of the cystic duct, the common bile duct, the head of the pancreas, and the second part of the duodenum is made. They are first inspected and then palpated. To do this, the surgeon should place his right thumb in the opening of the foramen of Winslow (*foramen epiploicum*) and palpate the common duct between the fingers and thumb throughout its whole length to determine whether it contains any calculi. If the surgeon is standing on a stool, it is easier for him to place the right index finger in the foramen and to carry out palpation between the forefinger and thumb with the hand pronated. Hard glands beneath the pylorus or in the region of the head of the pancreas may cause some uncertainty. The decision whether the common bile duct is to be opened should be made at this stage of the operation if possible. Particular attention should also be paid to palpation of the gall bladder to determine the type of stone present. If it is decided to open the duct, it should be done at this stage.

It is also at this stage that the decision is made whether cholecystectomy shall be proceeded with or cholecystostomy performed. The decision is mainly dependent on the pathological conditions which have been displayed and the exposure obtained in the region of the cystic duct. Thickening and edema of the wall of the gall bladder, especially if recently acute and associated with a similar condition of the mesentery of the cystic duct, favor the choice of cholecystostomy as the operative procedure.

Having made the decision to remove the gall bladder, either without or after opening the common bile duct, the surgeon should consider whether exposure is adequate, whether he should remove the gall bladder beginning at the fundus or at the cystic duct, and whether he should first open the gall bladder and remove its contents. If exposure is inadequate, various steps may be required: It may be necessary to increase the depth of anesthesia, to enlarge the incision, to raise or lower the bar of the table, to alter the position of the patient on the table, or to try a different position. Other methods used by surgeons are to divide the ligamentum teres between ligatures and thus to allow the liver to be tilted forward; to place a pack above the liver; or even to bring about collapse of a distended stomach by inserting into it a cannula attached to a suction apparatus.

The gall bladder should, whenever possible, be removed from below upward. In some instances when the cystic duct and its mesentery have been tied and divided, however, it may be more convenient to do the actual removal of the gall bladder itself from the fundus down. In those cases, however, in which, owing to the pathological state of the gall bladder and particularly of the tissues in the region of the cystic duct, removal from the fundus downward may appear to be the method of choice, simple cholecystostomy is often preferable. In cholecystectomy,

when the operation is performed from the fundus down, the common duct is much more liable to injury than when the operation is begun at the cystic duct.

Removal of the contents of the gall bladder frequently makes the operation considerably easier, and should be done in all cases in which access to the region of the cystic duct is difficult or is obscured by a dilated gall bladder, and particularly when a large stone is impacted in Hartmann's pouch. A purse-string suture, about 1 inch in diameter, is placed around or near the apex of the gall bladder and the area is held taut with forceps. The gall-bladder area is thoroughly packed off with sponges and a special trocar and cannula attached to a suction apparatus are plunged into the center of the purse-string suture and the fluid contents of the gall bladder are removed. As the cannula is withdrawn, the purse-string suture is tied. If large stones are present, before removal of the cannula, it may be necessary to enlarge the opening sufficiently for a scoop to be inserted to remove them. The purse-string is tied tightly and the end is left long to be used for retraction.

A curved clamp is now placed on the fundus of the gall bladder (Fig. 2). In the placing of clamps, which should be long-handled, curved, and blunt-pointed, their tips should be beyond gall-bladder tissues if possible, and they should not be placed on the gall bladder until it has been determined that the common duct is clear and that cholecystectomy is to be performed. Three pads are then placed in position, one in the right subhepatic pouch, one in the left to keep the stomach to the left, and one over the transverse colon. This last mentioned pad is covered by the left hand of the first assistant, who draws the tissues down from the lower surface of the liver in such a way that the right edge of the lesser omentum is taut and free.

A second curved forceps is then placed on Hartmann's pouch and this forceps held by the second assistant (Fig. 2). When retracted, this straightens the cystic duct and makes the lower border of its mesentery taut. This border is then incised just below the neck of the gall bladder by a pair of scissors (Fig. 2, A) and, by dissection with gauze on sponge forceps (Fig. 2, B), the peritoneum and fatty tissue are stripped until the common bile duct is exposed medially and the cystic duct above. As soon as the cystic duct is exposed, it is usually necessary to remove the forceps from Hartmann's pouch and to place it at a lower level, so that when retracted the cystic duct is still taut. At this stage the common duct is liable to injury, as in some cases it may be drawn upward and may either be inadvertently surrounded by a ligature or tied in a V-shaped manner at its junction with the cystic duct. This may happen not only in difficult cases but also in those in which the gall bladder can be brought up with unusual ease. The common duct can be recognized from its situation, its appearance, color, width, and thickness, and by the arrangement of the veins upon its walls. When the cystic duct comes into view a special curved dissector is passed close to and immediately above the duct (Fig. 3); it is then withdrawn and a pair of long-handled curved forceps is passed through the opening. The blades are then slightly and gently opened (Fig. 3, A). This strips the mesentery from the cystic duct which is now free and which should be seen in its length. Care must be taken when small stones are present in the gall bladder and the cystic duct is dilated, to see that no stones or débris are allowed to enter the common duct from the cystic duct during the performance of these manipulations.

At this stage it is necessary to review the decision to open the common duct. In some cases the stones in the gall bladder may be so large and in others the lumen of the cystic duct so small that it is obvious that no stones could have passed from the gall bladder into the common duct. The common duct is again inspected and palpated, and the final decision whether it should be opened is made. Most careful examination may be required, and if there is still any doubt at this stage the duct should be explored.

Having decided to proceed with cholecystectomy, the surgeon places a clamp on the cystic duct, close to the common duct, and another at its junction with the gall bladder (Fig. 3, B). The lower one must be as close as possible to the common duct and its tips must be free. It is then removed and the crushed area is securely tied with catgut (Fig. 3, C); many surgeons prefer silk for this ligature. If necessary, a second tie is made. The duct is then cut at least ⅛ to ¼ of an inch distal to the ligature (Fig. 4, A). The ligature is left long and is secured by artery forceps, but must not be retracted by the assistant for fear of its being displaced.

The cystic vessels are then secured in their mesentery. Clamps should be avoided during this procedure. Isolation of the vessels is unnecessary and may be dangerous. The liver lies above the mesentery, the common hepatic duct to its left and behind it, the gall bladder above, and the divided cystic duct below. The width of the mesentery is from ¼ to ½ inch and it may be

wider; its length is from 1 to 2 inches. The cystic artery arising from the right hepatic artery runs up in the substance of the mesentery, reaching it usually by passing behind the common hepatic duct. In rare instances a loop of the right hepatic artery may pass into the mesentery; it usually can be easily recognized by its size and direction. A blunt, ligature-carrying dissector should be used, and if this is passed immediately above the stump of the cystic duct as directed and to the right of, and some distance from, the common duct (Figs. 4, B and 4, C), there is little or no danger of injury to the right hepatic artery or common duct. The mesentery is divided close to the gall bladder, the surgeon making certain that at least ⅛ inch of tissue is left beyond the ligature (Fig. 4, D). If it appears likely that less than this will be left after division of the mesentery, another ligature should be passed and tied before it is divided. Ligatures are left long and secured by artery forceps and must not be retracted by the assistants. After the division of the mesentery, any bleeding vessel should be secured in a clamp and immediately tied.

The technique described is aimed at avoidance of accidental injury to the common duct, the correct placing of the ligature on the cystic duct, and the avoidance of hemorrhage from the cystic artery. These objectives are obtained by complete visualization of the cystic duct and its junction with the common duct, by division of the cystic duct before the cystic artery is tied, by the avoidance of clamps on the cystic artery, by ligature of the cystic mesentery before division, and by division of the cystic duct and cystic mesentery well beyond their ligatures. Attempts to isolate the cystic vessels separately are considered dangerous and, particularly, attempts to ligate them before division of the cystic duct.

It remains only for the gall bladder to be removed. There are several methods for its removal, the simplest being employed. The removal is best begun at the right side of the gall bladder, just above the level of the cystic duct. A second pair of curved forceps is applied to the cystic duct, as the one already on the duct sometimes tends to slip off during the subsequent manipulation. The peritoneum is divided on the right lower portion of the gall bladder and, by means of a pair of curved scissors, its lower end is freed. Incisions may now be made in the peritoneum on each side of the gall bladder, or it may be removed by scissors dissection from below. A pair of right-angled scissors is useful for this purpose. It is often convenient to stop this dissection when it is half completed and finish the first part of the subsequent suture (Fig. 5). After the removal of the gall bladder a clamp is placed on the tissues at the upper end of its bed.

At times it may be more convenient, after ligature of the cystic duct and artery, to remove the gall bladder from above downward. If the gall bladder has sufficient mesentery, one or more clamps may be applied to it and the gall bladder simply cut off. Infiltration of the gall-bladder bed to facilitate its removal has been recommended by Wilkie; this, however, is not always simple and there is danger that the gall-bladder wall may be perforated with the point of the needle. When the cholecystectomy itself is carried out from above downward, it is usually advisable first to open the gall bladder and to remove its contents. If the dissection between the gall bladder and its bed is carried out in the right layer, the gall bladder often strips very easily. When the neck of the gall bladder is reached the cystic mesentery is carefully ligated and divided, the gall bladder being left attached only by the cystic duct. This is carefully crushed, tied, and divided, particular attention being paid to the site of its division in relation to the common duct.

When the gall bladder has been removed, it should be taken away and opened immediately by an assistant. It should be split longitudinally and the cystic duct laid open. The specimen is viewed by the surgeon who notes particularly the size of the cystic duct and the number, nature, and size of the stones present. A stone to fit a facet on another stone may be absent, suggesting its presence in the common duct. Injury to the common duct may also be discovered at this examination.

The gall-bladder bed is now carefully examined for bleeding. If the steps of the operation have been correctly followed, the only bleeding at this stage should be from the cut edges of the peritoneum or oozing from the liver bed. The former is dealt with by artery forceps and ligatures, the oozing from the liver bed by pressure, hot packs, and the subsequent suture. When bleeding is under control, the suture in the gall-bladder bed is completed. This suture is usually begun when about half the gall bladder has been freed from its bed, the gall bladder being gently used as a retractor (Fig. 5). The first bite of the needle should be passed through the mesentery of the cystic duct close to the ligature already placed there in such a way that the suture is a second insurance against bleeding from the cystic artery. No attempt is made to suture the peritoneum over the cystic duct unless this can be done very simply and without difficulty. Using a long, semi-round needle

and a Gentile needleholder, the surgeon oversews the gall-bladder bed with a continuous mattress suture of plain catgut (Fig. 6). The length of the needle is important. Short needles are apt to tear the liver and to cause unnecessary bleeding. The end of the suture is left long and secured by forceps. Hemostasis is again checked and any bleeding is dealt with by tying or by the insertion of hemostatic sutures which, if they pass through the liver, must be very lightly tied. If any oozing is still present, it may sometimes be controlled by the application of dry aristol powder. All blood is mopped out, packs are removed, and a clean pack is placed beneath the liver.

At this stage the appendix is best removed. It can usually be brought into the wound without great difficulty. When it does not come up readily, the base is secured and an untied ligature is passed beneath the appendix at its junction with the cecum and used to retract it. Appendicectomy is then performed in the usual manner.

The gall-bladder area is now re-examined for any signs of bile or bleeding. Bleeding from the liver can as a rule be easily controlled by a mattress suture, lightly tied. If any bile is present, its source must be investigated and the ligature which has been placed on the cystic duct must be carefully examined.

Packs are counted, the self-retaining retractor is dismantled, and the gall-bladder rest is lowered. A small tube is placed beneath the liver and brought out through the upper angle of the wound. This is considered safer and is preferred to a stab wound in the right loin, which is favored by many surgeons. A stab wound, at times, is the cause of troublesome bleeding. The tube is fixed in position by a stitch of silkworm gut through all layers of the abdominal wall, at each end of which artery forceps are placed. The end of the tube should lie so that its lower end is at the level of the cut end of the cystic duct (Fig. 6, *X*).

It should be the rule to insert a drainage tube, particularly if there has been any soiling of the wound by bile or by the contents of the gall bladder, if there is any oozing of blood, or if the common duct or gall bladder have been opened. On no account should a pair of artery forceps be placed on the end of the tube to be removed later in the ward, particularly if the common duct has been opened. The most serious accidents have been reported from omission to remove the forceps after the patient has been returned to bed. In many cases the peritoneal cavity may be closed without drainage if the operation has been easily carried out and when the operative area is quite dry and all raw surfaces are well covered. If, however, there is the slightest oozing, a drain should be used.

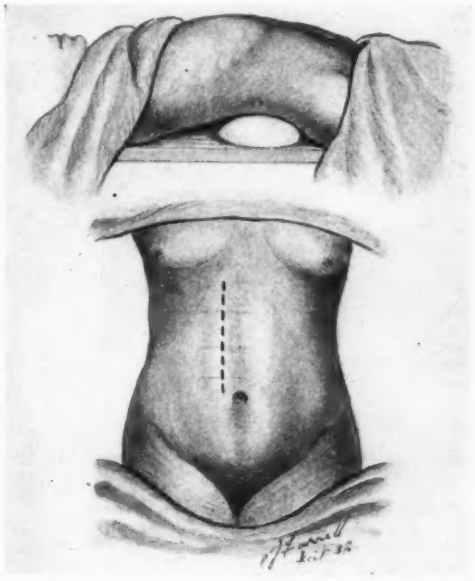

Fig. 1. The upper diagram illustrates the position of the patient for operation, with a sandbag or gall-bladder rest placed at the level of the lower costal margin. Below is shown the site and length of incision with the transverse scratches made on the skin to facilitate accurate apposition of the skin.

Closure of the wound. Before the peritoneum is closed, a careful check is made to see that all packs have been removed, that there is no free bleeding, and that the tip of the drainage tube is correctly placed. The omentum may then be brought up and packed under the tube into the operative area. The wound is then closed with meticulous care. Plain catgut only is used throughout. The position of the deep silkworm gut sutures is determined by the guide scratches made at the time of the skin incision. These sutures include the anterior rectus sheath; the muscle is avoided. The suture holding the tube is cut so that its ends are twice the length of those of the other sutures, and so that it may be readily recognized during after-treatment.

CHOLEDOCHOTOMY

While the decision to open the common duct may have been made before operation, in many cases the decision may be delayed until the gall bladder and common duct have been exposed.

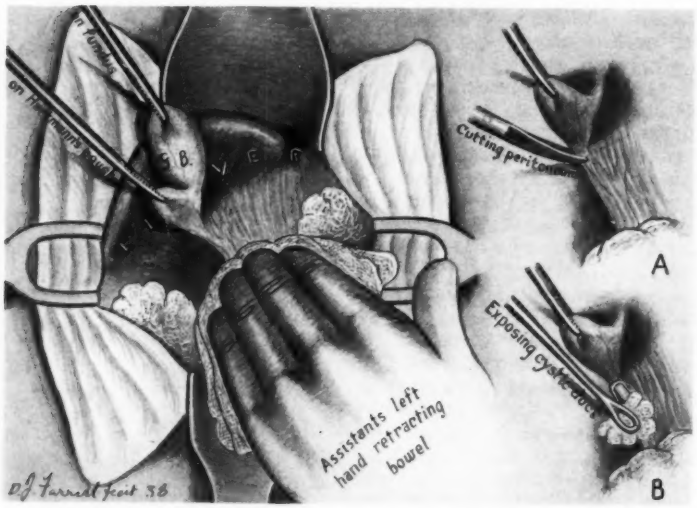

Fig. 2. Exposure of the gall bladder and bile ducts. A four-bladed, self-retaining abdominal retractor is used and pads are placed, one above the transverse colon, one on the right, and one on the left. The field is exposed by the left hand of the first assistant. Clamps are shown on the fundus of the gall bladder and in Hartmann's fossa. The latter, when retracted, straightens the cystic duct. A, The site where the peritoneum is opened; and, B, the stripping of the cystic duct.

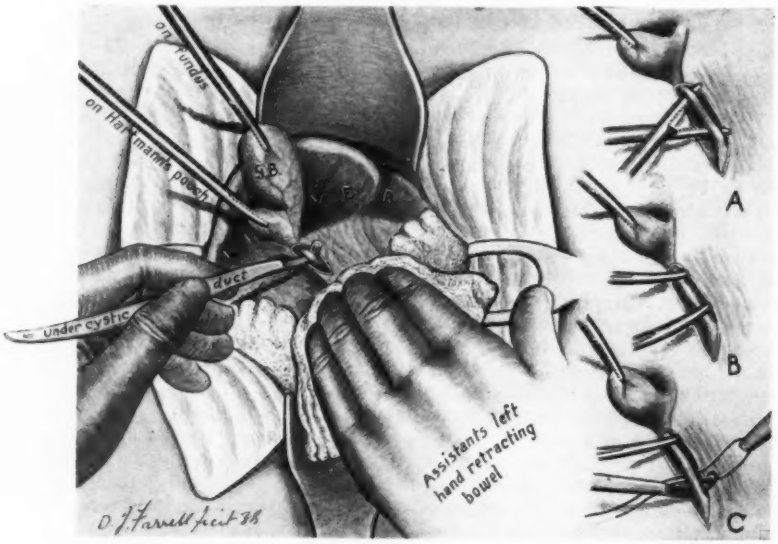

Fig. 3. Isolation of the cystic duct. A curved dissector is passed immediately above the cystic duct; through the opening thus made is passed a pair of curved forceps which is gently opened; A, displaying the cystic duct and its junction with the common duct. Clamps are applied to the cystic duct near the gall bladder and as close as possible to the common duct, B. The latter clamp is removed and the crushed area tied prior to division of the duct, C.

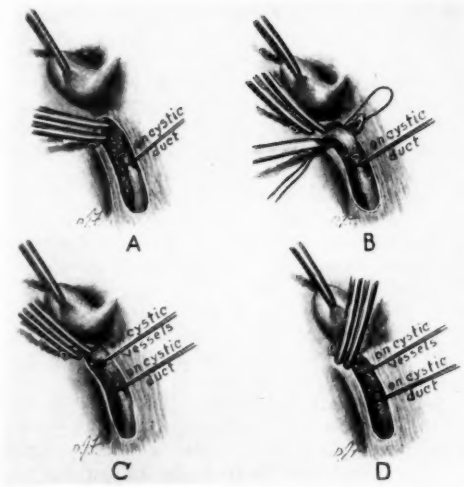

Fig. 4. Division of the cystic duct and ligature and division of the cystic mesentery. A, Division of the cystic duct and a second pair of forceps placed on the duct. No attempt is made to isolate the cystic vessels which are included in the ligature passed through the cystic mesentery, B and C, which is then cut; sufficient tissue being allowed beyond the ligature to prevent slipping, D.

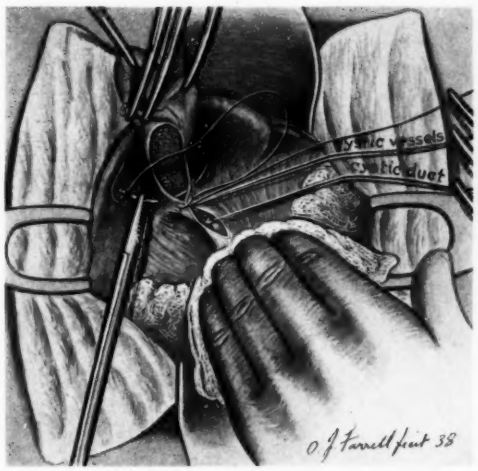

Fig. 5. The beginning of the suture of the gall-bladder bed before removal of the gall bladder, the first suture being placed in the cystic mesentery to reinforce the ligature.

The opening of the common duct increases the danger of the operation and is not necessary in most cases. Some surgeons, however, advise it as almost a routine procedure. Failure to open the common duct when required may have very serious consequences.

The decision is guided by the following considerations: There is no need to open the common duct (1) when there is a single large calculus or when there are a number of calculi out of all proportion to the size of the cystic duct; (2) when there is a very small and attenuated cystic duct. The common duct should be opened (1) when a stone can be felt along the course of the duct; (2) if jaundice was present on admission, even though the jaundice has subsided at operation—a history of jaundice during a former attack is not sufficient indication unless supported by conditions found on examination of the duct itself—(3) if the cystic duct is dilated; (4) if the common duct is dilated, unless there are clear indications against doing so—dilatation of the common duct of moderate degree, however, probably occurs as a secondary phenomenon without the presence of calculi within it in most long standing cases of non-functioning gall bladder; (5) in all cases of doubt, especially if there is thickening of the head of the pancreas, apparently not malignant, or if a small contracted gall bladder is present.

The operative technique is the same as that already described for cholecystectomy until the exposure of the cystic and common ducts (Fig. 2, A). No clamps should be applied to the gall bladder until it has been decided what is to be done with it at the conclusion of the operation on the common duct. Very frequently at this stage it is wise to go on to the isolation of the lower part of the cystic duct. If a ligature is then placed in the opening so made, it acts as an excellent retractor (Fig. 7, A). The further procedures are somewhat dependent upon the conditions which are found. One or more stones may be found within the duct or a stone may be felt impacted in Vater's papilla.

The opening in the common duct can usually be made at the site of election, which is just below its junction with the cystic duct. The cystic duct should be clearly visible and held taut during this procedure (Fig. 7, A).

Before the duct is opened, some bile is withdrawn with a syringe and needle at the site of the proposed incision (Fig. 7, B). Some bile now seeps through the needle hole and on each side of this strong, fine, silk sutures are passed on a small, curved needle. These two silk sutures, held long, are now used to steady the duct while a longitudinal incision about ½ inch in length, is made

Fig. 6. The suture of the gall-bladder bed completed. *X* is the site at which the lower end of the tube should be placed.

into it (Fig. 7, C). The line of the incision should be such that if it is extended upward it will extend along the cystic duct. Any bile which escapes is aspirated by suction and any stone which is situated beneath the incision is extracted with forceps.

The duct then is carefully palpated for calculi and by means of a malleable lead probe the duct and the hepatic ducts are gently explored (Fig. 7, D). By means of a blunt scoop, any stones present are removed. The probe is then passed into the duodenum. The surgeon having made certain that no calculi are present, the sphincter of Oddi is carefully dilated (Fig. 7, E). This is done by the passage of graduated single-ended metal Hegar sounds (Fig. 7, E). No attempt to overdilate the sphincter must be made. Graduated sounds should be used and the largest size used should pass easily down the duct. Finally, with a sound *in situ*, the duct is again carefully palpated. The mere passage of a sound into the duodenum cannot be taken alone to exclude the presence of stones in a dilated common duct.

Stones in the lower parts of the duct can usually be scooped out or milked by the fingers into the upper part of the duct. Stones impacted in Vater's papilla can usually be gently coaxed into the duodenum. Either of these procedures must be carried out with great care. If bile sand is present, it may be washed out of the duct with saline solution introduced through a soft rubber catheter. It is rarely necessary to open the duodenum for the extraction of a stone from Vater's papilla or from the lower part of the duct; to do so adds considerably to the gravity of the operation. It should be attempted only after the methods described have failed.

The wound in the common bile duct is now sutured with fine gut (Fig. 7, F). Some surgeons prefer fine silk. Over this, if possible, is sutured the peritoneum, sufficient space being left for the escape of any bile which may seep through the stitch holes.

A decision must now be made whether to perform a cholecystectomy or a cholecystostomy. The usual practice adopted in these cases is to perform a cholecystectomy. Drainage is important. It has been the practice never to place a drain within the common duct. The most careful attention, however, is given to drainage of the area adjacent to the opening in the duct. One and frequently two tubes are passed to this site, one through the upper angle of the wound, the other through the right loin. Experience has shown that when two tubes have been so placed at times one tube and at other times the second tube carries the greater drainage. The provision for the effective drainage of bile is most important and greatly minimizes the danger. In all cases in which the common duct has been opened, however dry the wound or perfect the closure may appear, drainage of bile must be anticipated.

CHOLECYSTOSTOMY

Cholecystostomy, which was formerly employed for the treatment of gall stones, has now largely been replaced by cholecystectomy. It is frequently followed by recurrence of symptoms and of calculi. It should be reserved for those cases in which cholecystectomy is contraindicated by the general or local conditions, and should be carried out in bad risk patients or in acute cases in which adhesion and infiltration of the mesentery of the cystic duct are present and in which cholecystectomy is judged to be dangerous.

The gall bladder is exposed and the contents of the gall bladder are removed as previously described. In the removal of the contents in these cases, considerable difficulty is not infrequently experienced with one or more small stones impacted in the cystic duct or in Hartmann's pouch. These stones may easily be overlooked if not carefully sought for, and failure to remove them results in a persistent mucous

fistula. If they cannot be reached with the scoop or milked up by the fingers, either an incision should be made over them or the lower border of the gall bladder should be completely split down until they can be removed.

After removal of the stones, a long wide rubber tube should be placed to just below the midpoint of the gall bladder and fixed by a stitch to the fundus. The purse-string suture previously inserted is tightened and a second purse-string suture is inserted in such a way that the wall of the gall bladder may be invaginated. If the gall bladder is grossly thickened it may not be possible to insert this second purse-string suture; in these circumstances, a number of interrupted sutures should be placed on each side of the tube. The gall bladder is not sutured to the abdominal wall. The gall-bladder rest is lowered and a stab wound is made at the point on the abdominal wall close to the costal edge where the gall bladder comes in contact with it. The tube is brought through the stab wound and fixed by a stitch of silkworm gut. The end of the tube is left long and brought out through the dressings. The application of a clamp to the end of the tube is particularly dangerous and may result in the escape of a considerable quantity of bile into the abdominal cavity. The area near the cystic duct may be drained by a second tube through the upper angle of the wound if it is thought necessary. The abdominal wound is closed as previously described.

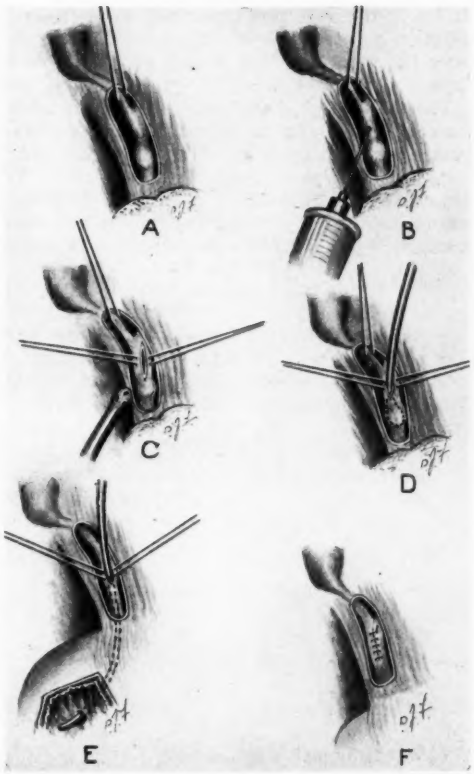

Fig. 7. Choledochotomy. A ligature has been passed above the cystic duct for retraction and the common duct has been exposed, A. A needle has been inserted into the common duct and some bile withdrawn, B; silk sutures have been placed through the coats of the common duct and the incision made into it; the line of incision should, if extended upward, pass on to the cystic duct and not as shown in the diagram, C. The ducts are explored, D, and small graduated dilators are then passed, E. The wound in the duct is then sutured, F.

POSTOPERATIVE COMPLICATIONS

The main dangers of cholecystectomy arise from attempts to perform the operation in unsuitable acute or subsiding cases, when the mesentery of the cystic duct is thickened and indurated and anatomical landmarks are not clear, or in cases in which satisfactory exposure of the cystic-duct area is not obtained.

Apart from those complications which ordinarily may follow any abdominal operation, the special postoperative complications may be due to local or general bile peritonitis, the result of non-drainage, inadequate drainage, clamping drainage tubes, slipping of the ligature from the cystic duct, unsuspected injury to the bile ducts, the presence of unrecognized accessory ducts, or an escape of bile from the gall-bladder bed. Serious complications may follow bleeding from the cystic or hepatic artery, injury to the portal vein, or unsuspected ligature of the right hepatic artery or the common bile duct. Bleeding may also occur from the liver, from adhesions which have been separated, or from the omentum. When dense adhesions are present, injury to the transverse colon, the duodenum, or the stomach may occur. In addition, a persistent mucous fistula may follow cholecystostomy if a stone is left in the cystic duct, and cholangitis, infection of the liver, or stricture of the duct may follow choledochotomy.

AFTER-TREATMENT

After recovery from the anesthetic the patient is treated in a sitting up position for from 2 to 10 days, depending upon his condition and the circumstances of the recovery. Deep sutures are removed on the eighth day and superficial sutures

on the tenth day, provided there is no wound infection and the patient has no cough. In such cases the sutures should be left another 3 to 4 days.

The removal of drainage tubes depends upon the conditions found at operation. In the after-treatment of patients in whom there has been merely a little oozing of blood, the tube is removed several days after operation. It is the rule to shorten tubes 1 or 2 days before removal; in others, tubes of the same length but of lesser caliber are inserted. If there is much drainage the tube may be left in for 5 to 8 days. In all cases in which there is drainage of bile the tube is left in for 8 to 10 days. When two tubes are used the tube which is not draining is removed. After cholecystostomy the stitch in the tube is removed on the tenth day and a safety pin is inserted, but no attempt is made to loosen the tube. The next day shortening of the tube is begun until it is removed. The patient is allowed to be up in from 14 to 16 days.

A NEW PLAN OF ANTECOLIC DUODENOJEJUNAL ANASTOMOSIS

FRANK H. LAHEY, M.D., F.A.C.S., Boston, Massachusetts

ONE of the most difficult problems with which at times I have had to deal has been the satisfactory restoration of the alimentary canal after resections of the jejunum at such a high level that following the removal of the upper jejunum either for jejunal ulcer or annular carcinoma there remained such a short intraperitoneal jejunal stump that lateral anastomosis was impossible and end-to-end anastomosis unsatisfactory and even unsafe. When subtotal gastrectomy together with jejunal resection must be done for jejunal ulcer in a patient upon whom a no loop gastro-enterostomy has been done the remaining upper end of the intraperitoneal jejunum is often distressingly short. It is often so short that if an end-to-end anastomosis is made the upper stump of intraperitoneal jejunum is so used up by the anastomosis that the suture line is retracted up to or beneath the mesenteric root and obstructed by pressure from that structure.

A similar difficulty arises when an annular carcinoma of the high jejunum must be resected as shown in Figure 1 and in the diagrammatic illustration of such a case in Figure 2. As may be seen in Figure 2, the problem with which I had to deal in this case was that following the removal of the annular malignancy of the jejunum with adequate amounts of normal jejunum on each side of the lesion there remained such a short intraperitoneal jejunal stump that safe anastomosis of the remaining jejunal ends was impossible. As the result of this dilemma the procedure here described and illustrated was conceived and employed. It has since proved valuable in high resection of the jejunum for gastrojejunocolic fistula. It is described with the possibility that it may prove useful for others who find themselves in the same predicament.

In Figure 1 the x-ray picture demonstrates the high level of the almost completely obstructing lesion. Figures 2 to 5 demonstrate quite satisfactorily the technical steps of the plan of procedure.

From the Department of Surgery, The Lahey Clinic.

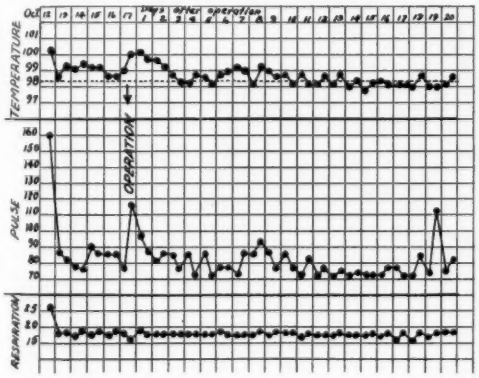

Chart 1. The postoperative chart in the case presented in these illustrations.

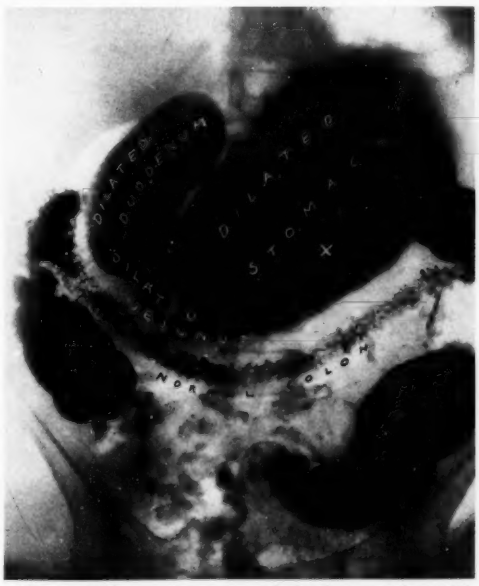

Fig. 1. This roentgenogram of the first case in which this plan was employed shows the dilated jejunum and stomach above the high level of jejunal obstruction from an annular carcinoma of the high jejunum. The actual level of obstruction is not shown in this picture since its retrocolic position is overshadowed by the dilated stomach, duodenum, and upper jejunum.

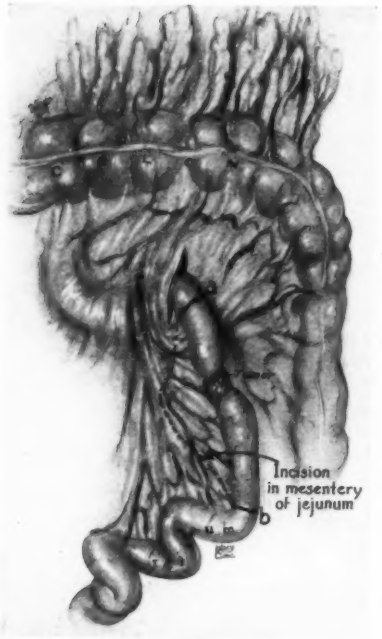

Fig. 2

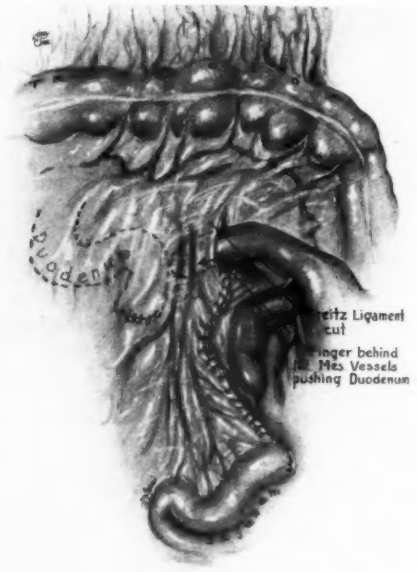

Fig. 3

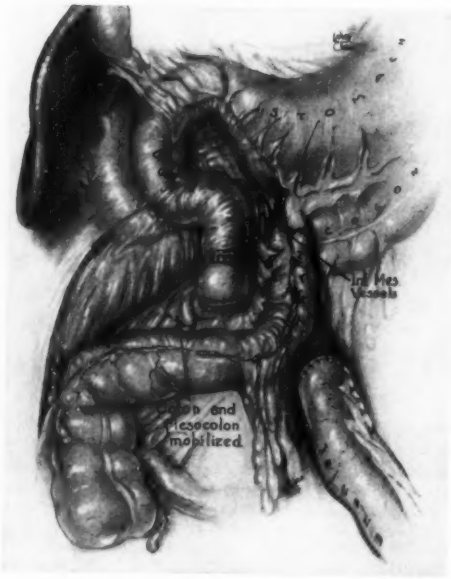

Fig. 4

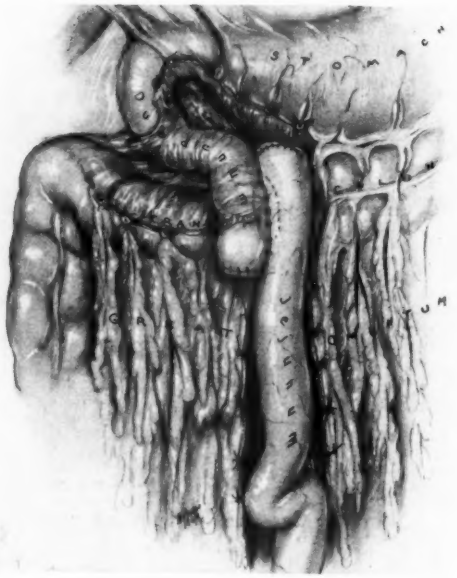

Fig. 5

(*Legends on opposite page*)

CLINICAL APPLICATION

This operative plan has been satisfactorily employed in a patient with a gastrojejunocolic fistula in whom it was necessary to resect the stomach, jejunum, and the right half of the colon up to the splenic flexure. It proved even more feasible in this case since following the removal of the transverse colon the jejunal stump could be transposed beneath the mesenteric root and a lateral anastomosis made between it and the lower jejunal stump without the necessity of carrying the two ends in front of the colon.

While one may with this operative plan employ either lateral or end-to-end anastomosis I have preferred the former because with it there is less even temporary high jejunal obstruction, a factor which even though it may be only of temporary character can swing the balance in the postoperative recovery of serious cases in an unfavorable direction.

Fig. 2. This semidiagrammatic drawing demonstrates the location of the carcinoma in the upper jejunum. Lines *a* and *b* together with the dotted lines demonstrate the amount of jejunum which it was necessary to remove together with its attached mesentery. The shortness of the remaining intraperitoneal jejunal stump as relates to a safe end-to-end anastomosis reveals very well the dilemma in which I found myself. It was readily appreciated from past experiences with high jejunal resections and anastomosis in patients who had developed jejunal ulcers after no loop gastro-enterostomy that no safe anastomosis *in situ* between the ends of remaining jejunum could be accomplished. To meet this situation the plan presented in the following illustrations was undertaken.

Fig. 3. In this illustration are shown both ends of the jejunum inverted and safely closed with mattress silk sutures. The parietal peritoneum about the ligament of Treitz and the point where the jejunum becomes retroperitoneal is shown incised about the jejunum so that that structure could be pushed behind the root of the mesenteric vessels into a retroperitoneal position. Following the withdrawal of the finger from the retroparietal peritoneum the remaining slit in the parietal peritoneum was closed by suture.

Fig. 4. In this illustration the lateral parietal peritoneum beside the hepatic flexure is shown incised and the entire hepatic flexure with its attached mesentery so turned down that the retroperitoneal duodenum together with the mobilized and transposed stump of jejunum is at once visualized. With freeing of the retroperitoneal duodenum from its bands of retroperitoneal tissue it will be found to have a sufficiently long mesentery so that it can be carried in front of the transverse colon when that structure is restored to its normal position by putting the hepatic flexure back to the point from which it was mobilized.

Fig. 5. In this illustration is shown the lower loop of jejunum and the upper loop of transposed jejunum and mobilized retroperitoneal duodenum carried in front of the transverse colon and continuity restored by lateral anastomosis. Note the slit made in the omentum to prevent pressure from that structure on the mesentery of the lower jejunal stump

REPAIR OF THE INCONTINENT SPHINCTER ANI

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THE purpose of this paper is to evaluate the present concepts of the surgical repair of the incontinent anal sphincter and to make a preliminary report of a new principle of approach which has proved superior in our hands. We have used our operation in a case in which the orthodox procedure failed miserably, the latter in this particular instance serving as a sort of control for having been attempted in our own hands; we have used it in a case in which the usual operation would have been impossible of successful accomplishment (Fig. 4); and we have used it as a primary operation of choice. In our admittedly limited series, which is comprised of cases of only the predominant types of injury, we have achieved in every instance an end-result which is not a compromise makeshift of indefinite classification but a restoration of physiological function indistinguishable to the patient from the original normal condition. Yet withal the operation is simple in plan and execution.

From a statistical study of 133 cases compiled from a questionnaire submitted to members of the American Proctological Society, it was readily seen that with but isolated exceptions an incontinent sphincter ani follows either obstetrical or surgical operations. Noteworthy as constituting a particularly serious indictment against surgery is the large number of cases in which the condition was brought about by a simple incision of an acute perianal abscess or by uncomplicated hemorrhoidectomies; without exception the sequelæ were entirely preventable and completely unforgivable. In 69 cases, or 51 per cent of the total, the condition followed fistulectomy, and this was by far the most important single cause. Rarely are such experiences unavoidable in the hands of a competent operator and but few proctological experts have ever been the instrument of their occurrence. We cannot speak for the obstetrician, who has much to answer for, but otherwise, certainly with but few obvious exceptions, the series represents the fruits of incompetence.

The vulnerability of the anterolateral quadrants to tragic operative injury in women is unmistakably indicated by the marked preponderance of such cases, in spite of the fact that fistulas occur more commonly in other sites. The fact that the injury occurred directly posteriorly in 15 cases, a site often mistakenly regarded as immune to such consequence (1, 2), should also be a warning.

In this series the usual procedure of freeing and uniting the ends by suture was used, as shown in Figure 1. However, the results (Fig. 2) indicate that the apparent simplicity and adequacy of the operation as suggested in texts and pictures is apt to prove illusory even in the hands of experts. Certainly any surgeon whose inadequacies have served as the inception of incontinence is not the one to extricate himself from the predicament by this operation. Such attempts, frequently multiple, have too often provoked that despair in the patient which has proved a deterrent to further surgery in more competent hands or has superimposed added difficulties to possible final correction. It is evident that the optimistic descriptions in the literature are not justified and that the operation leaves much to be desired.

It is noteworthy also from the statistical study that the obstetrical cases fared distinctly better than those of the "surgical" group, thus indicating the lessened incidence and virulence of infection in intravaginal procedures as compared to those through a skin approach. Seventy per cent of the series were reported as having exhibited varying degrees of infection, and this obviously constitutes the most devastating circumstance inimical to plastic surgery of this region.

In our own experience with this operation all details against postoperative infection which we could find reported or devise ourselves have been without avail; none of our cases remained entirely clean. These precautions have included studied pre-operative and postoperative care; the lifting of a wide flap to the site of repair; the absence of any intra-anal palpation or any finger contact with the wound; and the discarding of all instruments once used. While, as a rule, favorableness of outcome varies inversely with degree of infection, occasionally even the worst infection did not prevent a favorable outcome. As this fact has an interesting implication we shall allude to it later.

Next in importance to the overwhelming hazard of infection as an explanation of unsatisfactory results is the difficulty in dissecting out the frayed muscle ends buried in scar tissue. Apparently a simple task in pictures, it is more often than not

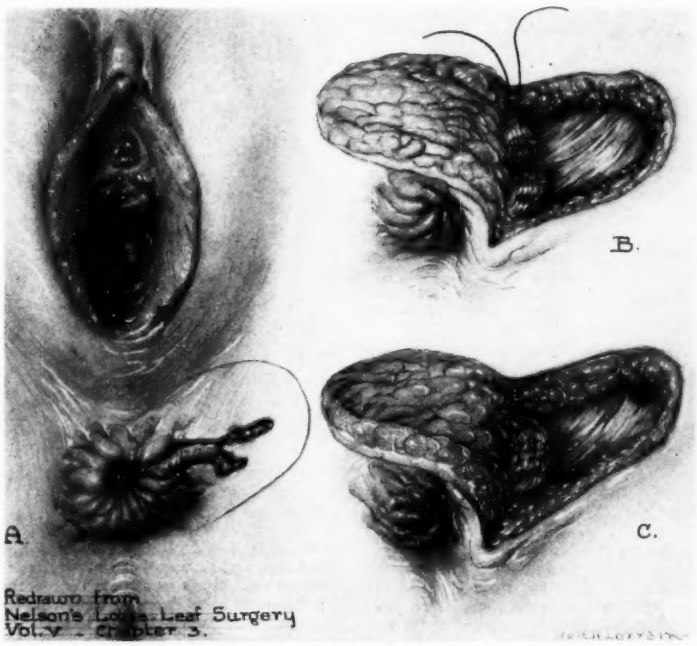

Fig. 1. Usual plastic operation for repair of the incontinent sphincter ani. Attention is directed in the text to difficulties with what here appears to be a simple and adequate procedure.

insuperable to those whose anatomical and surgical familiarity with the region is limited largely to reference sources and occasional operation. Indeed, this inherent difficulty has occasioned the belief by some that atrophy of muscle tissue must occur. While such an assumption is not outside the range of possibility, it is not supported by the consideration that the duration of incontinence in this series before attempted repair was found to have no bearing on surgical prognosis; for time is the essence of such atrophy. Furthermore we have experienced this difficulty of identification only to find easily perfectly normal muscle on subsequent attempt at an unimpaired site, as we shall later report. And, if enough muscle is dissected out to insure proper identification and apposition, and without too much tension, one encounters the opposed problem of final stenosis.

These two insurmountable defects then are connate with this type of operation and, admitting inevitable sources of failure, must remain barriers to uniform and dependable success. This is true from a theoretical standpoint and in the light of our statistics relative to the method.

Buie has recently formulated a new method of attack which is deserving of comment. In his opinion the loss of constricting power is due almost exclusively to extended postoperative packing, with its resultant interposition of excessive scar. He advises that it is only necessary through simple excision of the scar tissue to recreate the cavity which existed immediately following fistulectomy, then to allow the wound to heal by granulation without recourse to the muscle suturing of the more difficult orthodox operation.

Fig. 2. End-results in our reported series with operation shown in Figure 1.

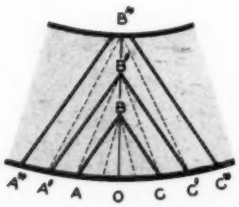

Fig. 3. Schematic representation of segment of sphincter ani showing results of operative injury. Niche *ABC* represents retraction following incision *O B* and is assumed to be too small to cause even temporary incontinence. The latter is prevented by the splinting effect of the unsevered portion and fortunately represents the most common situation. Niche *A' B' C'* would similarly follow incision *O B'* and is assumed to be of sufficient magnitude to cause temporary incontinence. Here the deficiencies of splinting due to too deep severance would be sufficiently counteracted by the contraction of scar tissue during normal healing as to result in the dotted niche *A B' C*, by which continence would return as the final result. By prolonged postoperative packing, however, which would prevent this contraction, the niche *A' B' C'* would remain unchanged and the temporary incontinence become permanent. The niche *A'' B'' C''* represents the result of incision *O B''*, and by similar reasoning, even if normal healing were permitted it could not overcome the handicap of deficient splinting due to too deep severance, and even the optimum end-result *A' B'' C'* would mean final incontinence. Thus, theoretically, only in certain cases does packing make the difference between continence and incontinence. Only in those, in which lack of splinting due to too deep or multiple severance has not been a factor, would re-creation alone of the original wound, and this time with correct postoperative care, cure the incontinence. As the factor of packing is often difficult of determination from either the history or examination there would seem to be difficulties in the proper selection of cases.

A study of Figure 3 will show in theory how the effectiveness of this type of procedure depends upon the rôle of excessive postoperative packing.

Although we have not tried the Buie type of operation as such, it is theoretically possible that in cases due chiefly to prolonged postoperative packing superior results might be obtained. Indeed, one probably unwittingly effects this operation not infrequently despite his execution of the usual plastic repair. This is in view of the high incidence of infection and the inevitable sloughing of sutures and tissue. That good results have been obtained on such occasions is probably evidence favorable to the simpler operation.

According to the replies to our questionnaire, nearly all cases can be classified in 3 groups according to causes, namely, in order of importance: too deep severance, multiple severance, and excessive postoperative packing. These are commonly asserted in the literature but there analysis has stopped. Possibly unstated because so simple, it must be recognized that there is a still more

Fig. 4. Schematic representation of muscle reefing operation for the incontinent sphincter ani. Actually, this closely represents the condition in our second case report. In this patient the scar had replaced such a large segment of the muscle due to repeated operations that satisfactory dissection and suture of the muscle ends after removal of the scar would have resulted in far too small an anal outlet. On the other hand, reefing of a normal segment of muscle was easily accomplished and with excellent result.

basic factor common to all these—*a final inordinate increase in the circumference of the anus*. The importance of this dictum lies in the now obvious implication that any procedure which can be found to decrease the circumference, whether directed at the point of injury *or elsewhere* might benefit all patients with incontinence regardless of the causative mechanism.

Furthermore, it is essential to our thesis to point out the erroneous assumption as to the pathological physiology interpreted in relation to the abnormal mass of scar tissue—aside and above its rôle of increasing circumference by separating the muscle ends. That is, additional interference has been ascribed to the deformity occasioned by the mass of scar tissue *per se*. True, this concept has been hardly more than nebulous as far as any actual formulation has been concerned, but none the less operative as the focal point of remedial surgery. It has largely shaped both types of operation under discussion for these have been predicated on the removal of this scar tissue as an absolute essential. In some manner not made clear, and variously expressed—or unexpressed—the scar tissue interferes with contraction of the muscle "*on itself*." From all consideration and context the comparison may be fairly made to

Fig. 5. Vaginal incision for reefing operation. Scar at the site of original injury is here shown directly posterior and represents the actual condition in our first case. Immediately after the incision the anus is draped with a towel caught in the grasp of Allis forceps on the lower flap. The wound is deepened to the external sphincter ani which is first separated from subjacent tissue by blunt dissection with the knife handle. Grasped then with Allis forceps and with tension directly anteriorly the muscle band is readily separated down the sides.

the hindrance of a golf ball in the hand to complete closure of the fist.

It seemed to us on closer analysis that closure of the muscle *on itself* was not the decisive point, but rather that it closed on *something, even scar tissue;* that in the comparison with the golf ball in the hand, tight closure of the fist was not so pertinent as the effective apposition of the surface of the hand to the surface of the ball (Fig. 4); and thus, that if the slack were taken up by *any* method there would be improvement in function whether or not the scar tissue remained. That we have had success in the application of this principle is evidence of the verity of our premises.

Herewith is proposed a technically far easier and yet withal more effective type of operation which applies our theoretical premises and almost completely eliminates the demonstrated deficiencies of other operations. It is so simple in both concept and execution as to occasion surprise if it has not been utilized before, although no reference is found in application to the general

Fig. 6. Reefing operation, showing placement of first chromic suture through external sphincter. In our cases we have aimed at overcorrection, and the results point to the wisdom of this. Non-absorbable sutures should not be used, and no sutures throughout the whole operation should be tightly drawn.

problem; at all events, any extended familiarity or use is certainly negligible. We attempted it first after an utter failure of the usual plastic operation, and success was so dramatic and the patient so completely rehabilitated as to make it the primary operation of choice on subsequent occasions. Advantage is taken of a direct attack on the *anterior normal* portion of the external sphincter rather than on that portion mutilated by operation and deformed by scar tissue—heretofore utilized (Figs. 4, 5, 6, and 7). A reef is taken in the muscle, through the vagina in all of our small series, so that the circumference of the whole muscle and of the anal outlet is diminished. Dependence is placed exclusively on this effect with entire disregard of the scar tissue.

This operation not only largely eliminates the basic sources of failure of the other operations but its advantages are strikingly positive as well. The following differences merit emphasis:

1. Disruptive infection is favorably affected in a large proportion of the surgical group by the substitution of clean vaginal approach rather than through the perianal skin. As this group comprises 85 per cent of the total in this series, about three-fourths of them females, the significance of this advantage is evident.

Fig. 7. Reefing operation: muscle reefed and suture placed in lateral vaults for turning down reefed portion, and with slight upward tension. The incision is but lightly closed with a few interrupted sutures; even these should be removed immediately if any indication of infection should develop.

2. The procedure entirely obviates what is often the most difficult and yet essential step of the usual plastic operation, that is, accurate and adequate identification and dissection of the frayed ends of muscle buried in scar tissue. It substitutes, therefore, an approach to a normal and undivided muscle through normal and undisturbed tissues, a far easier course.

3. The success of any operation depends on the proper balance between tension of the muscle immediately following suture and the circumference of the anus in the final result. If there is too much tension, the sutures will not hold. In other operations this is entirely predetermined by the amount of scar tissue mass to be removed and hence is entirely uncontrollable, unless one takes a chance with resultant stenosis. Indeed, there are numerous instances, of which our second case is an example, wherein, after repeated clumsy rectal operations, the scar tissue occupies such a large part of the anal circumference as to prohibit any possibility of success following removal of the mass. With our operation, on the contrary, the opposing factors of tension and stenosis are entirely controllable, and in our illustrative case representing conditions at their worst, there was absolutely nothing added to the difficulties, either in the way of technical accomplishment or to the securing of an excellent result. Of course, replacement of over half of the circumference of the anus by scar tissue would impose an unsurmountable limitation.

4. There is augmentation of muscle area in apposition, of better quality and arrangement to hold more effectively during the period of healing.

In the obstetrical group, the orthodox plastic procedure has proved more nearly satisfactory and would seem to take precedence over muscle reefing, for in these cases attack on any normal portion of muscle would of necessity be shifted to the perianal skin. This approach might be utilized if further attempts seemed desirable. In other words, vaginal approach is probably more salutary, if one must choose, than approach to uninjured muscle.

Incontinence in the male occurs less frequently but the same advantages enumerated hold true except that of course anterior approach cannot be vaginal. Even so, the danger of infection following operation is considerably less in this site than posteriorly, due to habits of cleansing after bowel movements, and to the direction of soiling.

Our clinical experience with this type of operation is limited to 3 cases so that this feature must be considered in the light of a preliminary report. We prefer to make it at this time rather than delay a more seasoned report because the procedure is theoretically sound in concept and simple in execution, savoring nothing of a "stunt"; because our results have all been successful and, lastly, because even in the large amount of clinical material at our disposal these cases are so occasional that considerable time would elapse for any extended series.

Our first case, a nurse, was utterly incapacitated and confined to her home because of absolute incontinence following a fistulectomy 6 years previously. A plastic had been attempted elsewhere, and we ourselves had performed the orthodox operation for the defect in the midline, posteriorly. Complete failure was due chiefly to gross infection. Six months later we performed the reefing operation, our first experience, and with truly dramatic result. Completely rehabilitated, she regards present control not just as an improvement but as normal as ever before the onset of her protracted rectal difficulties, even as regards escape of gas.

Following this successful outcome we were encouraged to perform the operation in our second case, likewise a nurse, with a history of 7 operations elsewhere to repair a fistula. She possessed no control of flatus or soft stool and even with

constant care in choosing foods the fear of accident limited her activities by the necessity of ready access to a toilet. As nearly the entire right side of the sphincter was replaced by scar tissue (Fig. 4), removal of the latter would have meant inevitable failure. After our simple operation, however, she regained complete control even to the passage of gas; she does not have to watch her diet, and she can readily control the most urgent desire to defecate. The condition is no longer a matter of primary concern in her life; her existence is correspondingly happier and more useful.

The third case, a housewife aged 50 years, complained of her inability to control movements and total uncontrol of gas, since a fistulectomy a year previously. Also for several years she has had slight seepage of rectal contents into the vagina, antedating her present rectal history and of undetermined origin. Examination revealed a pin hole sized rectovaginal fistula just above the sphincter ani and a defect of the latter muscle in its right anterior quadrant. Reefing of the external sphincter was accomplished after plastic repair of the septum. Function has been restored completely.

SUMMARY

An evaluation of the usual plastic operation for repair of the incontinent sphincter ani is presented, based on a study of a series of 133 cases compiled from a questionnaire submitted to members of the American Proctological Society.

The theoretical basis, advantages, and technique of a reefing operation for the incontinent sphincter ani are presented and discussed.

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THE REPAIR OF DEFECTS OF THE FRONTAL BONE

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PATIENTS who have deformities of the face seem, at times, to suffer from mental depression that is out of proportion to the extent of the deformity, due to their avoidance of social contacts and the difficulty of obtaining many types of employment. This seems particularly true of patients who have defects of the frontal bone. Reconstructive surgery has been a great aid in rehabilitating these patients.

Defects of the frontal bone require correction for cosmetic reasons and for the alleviation of the symptoms that are due to absence of the full thickness of the skull. In the cases that we have operated on, they were performed to correct the defects largely from a cosmetic standpoint.

Defects of the frontal bone may be congenital due to persistence of the frontal suture, postoperative defects secondary to intracranial or extracranial operative procedures, osteomyelitis and trauma. The extent and contour of the disfigurement vary greatly, so that only rarely does one see two similar deformities. Malignancy of the frontal region, as in other situations, requires complete removal regardless of the resultant deformity, and with periosteal involvement a sequestrum frequently results. Frequently, the deformity that one sees in the frontal region is the bony defect secondary to removal of a sequestrum after treatment of an epithelioma by irradiation or surgical diathermy (Fig. 1). In the treatment of osteomyelitis of the frontal bone, there is a difference of opinion as to the advisability of conservative or radical treatment. The resultant deformity, of course, is of secondary importance and can be safely corrected only after healing is complete (Fig. 2). In general, it is best to wait for at least 6 months until the thickening and scarring have subsided. Radical surgical procedures for empyema of the frontal sinus or abscess of the frontal lobe are a frequent cause of deformity in this region. The frontal bone and the supra-orbital ridge may be pushed backward as the result of trauma. A common deformity due to an automobile accident is the displacement of the base of the nose, the glabella, and supra-orbital ridge which have been driven backward into the ethmoid region (Fig. 3). The patient is usually in a critical condition and any attempt at immediate replacement of the displaced bones might result in meningitis. Healing is permitted to take place and the deformity is corrected by secondary plastic procedures. In the healing of defects of the skull, periosteum grows downward over the shelf of bone and becomes adherent to the dura, so that an irregular contour of the skull is produced. This complete covering of the margins of the bone prevents the production of callus which ordinarily would fill and obliterate the defect.

From the Section on Laryngology, Oral and Plastic Surgery, the Mayo Clinic.

Read before the meeting of the American Laryngological Association, Rye, New York, May 24 to 26, 1939.

TREATMENT

The time of correction of the defect of the skull must depend on the etiological factor in its production. It is always best to wait until complete healing has taken place, until any sequestrum has been removed, and, if any sinuses are present, until all discharge ceases. Six months from the time of the last operation or the accident, in general, is the time of election. If the deformity is secondary to malignant disease, it is best to wait for at least a year, if the periosteum has been involved, to make sure that there is no recurrence. When the patient presents himself for reconstructive surgical alteration of a defective frontal bone of any extent, it is best to make a cast of the face, so that the defect may be built up in clay and the extent of the deformity determined. From the cast, lead patterns are obtained, both of the surface defect and of the depth of the defect. These may be taken to the operating room and used at the time of the reconstruction. It is essential that the patient be in the best possible general condition. If there is severe, wide scarring or displacement of the hairline or eyebrows, this should be corrected first by excision of the scars and adjustment of the soft parts. Correction of the contour consists of inserting some type of tissue to fill the defect. Artificial material such as gold, silver, ivory, and celluloid has been employed but we do not feel that any foreign material has a place in this type of work.

Richard and Macewen, and Lexer used dog bone and cow bone but these were absorbed and

a b c

Fig. 1. Repair of defect in forehead; a, postoperative defect of the frontal bone following removal of a malignant tumor a year previously. The sequestrum was removed but, due to the sclerosed bone, granulation did not come through in usual manner; b, a flap with the pedicle above the defect was turned from the left side of the forehead to cover the exposed bone and a skin graft was used to cover the area from which the flap was taken; c, immediate result after removal of the sutures.

did not permanently correct the deformity. Soft tissues, such as fat and fascia lata, may be used for small defects but we have found that cartilage and bone are the best materials for this purpose.

Free fat transplants have been used as the media to fill the defects of the frontal bone. Harter, in 1927, reported a case in which the defect was repaired with multiple, small grafts placed at several different sittings over a period of months. Figi, in 1931, reported a successful result, 13 months after operation, by the use of a large, single, free, fat transplant, overcorrecting

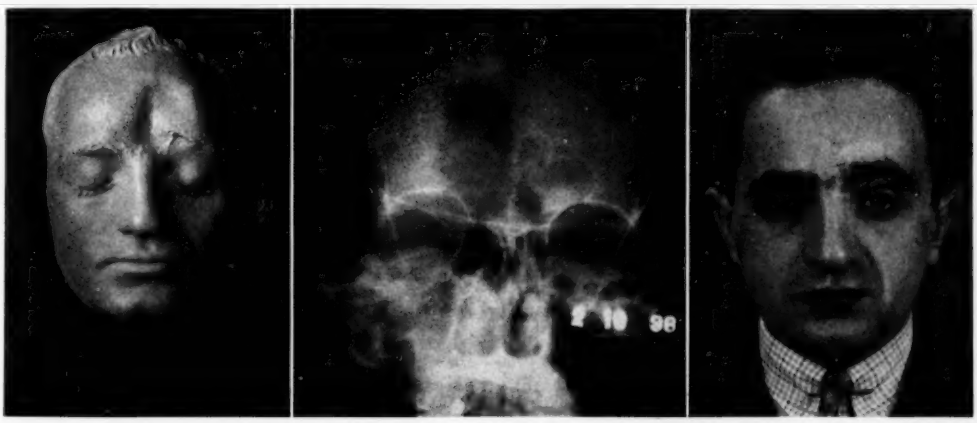

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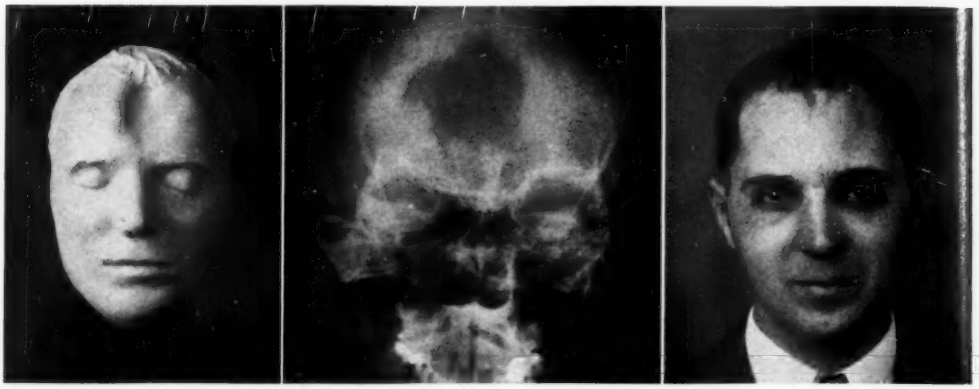
Fig. 2. a, Cast showing the defect of the frontal bone secondary to operation for abscess of frontal lobe; b, roentgenogram showing the extent of the bony defect; c, postoperative photograph 8 months later. The defect has been corrected with rib cartilage and the scarring of the forehead excised and the eyebrow adjusted.



a b c

Fig. 3. Repair of defect of frontal bone. a, Cast showing defect of frontal bone, of traumatic origin; b, roentgenogram showing the extent of the bony defect; c, photograph which was taken 2 months after operation in which cartilage grafts were employed in order to correct the deformity present.

at the time and thus allowing for partial absorption. Gurney, in 1938, in an experimental study on rats showed that only one-fourth to one-half of the free fat transplants survive and that "multiple pieces, in lieu of a single piece of equal bulk, is not a satisfactory procedure."

Fascia lata may be wadded into a shape that corresponds with that of the defect and may be inserted to restore contour. This is only applicable if the depression is slight. Being of a fibrous nature, fascia lata will remain as such or will be replaced by a similar substance and, therefore, only little overcorrection is necessary.

John Hunter (quoted by Keith) did much pioneering in bone grafting but did not obtain good results due to the lack of knowledge of asepsis. Paul Mueller first used the pedicle-sternum flap to restore cranial depression. Koenig and Mueller later executed a skin osteoperiosteal flap from the neighboring outer table of the skull, with fascia lata interposed to prevent adhesions between the brain and the bone graft. Hacker and Durante used an osteoperiosteal flap of the outer table twisted on a pedicle so that the periosteum contacted the dura or brain tissue. Both methods had the dangers of encountering severe hemorrhage and causing cerebral injury during the splitting of the outer table from the inner table.

Fig. 4. a, left. Traumatic defect of the frontal bone and nose secondary to automobile accident; b, cast showing defect in forehead and nose corrected with rib cartilage.

Free bone grafts were employed with good results for these defects, from the scapula (Leclerc), the tibia (Delagenière), the rib (Kahle), and the greater trochanter (Mauclaire). Sterilized free cranial grafts from cadaver skulls were used successfully by Sicard, Dambrion, and Roger in 42 cases. Their grafts were 0.5 centimeter thick and perforated by holes 0.5 centimeter apart.

In 1865, Bert reported his conclusions regarding cartilage grafts in experimental animals. Thirty-one years later, in 1896, Koenig first used autogenous cartilage grafts in man to repair partially destroyed tracheal and laryngeal cartilages. Costal cartilage was successfully used by von Mangoldt, in 1899, for the correction of deformities. Morestin of Paris, in 1916, described the cartilage graft for the repair of posttraumatic cranial defects. Villandre, Rouhier, Woodroffe, Gosset, Gilmour, Henle, Lexer, Schmieden, Wilson, Loeb and others made contributions to the work of using cartilage as transplants.

"Stored" cartilage is obtained at the time of removal of rib cartilage. The material that is not

used on that patient is stored in an aqueous solution of merthiolate or in a solution of metaphen and is kept in an icebox. It is used at times, particularly in the presence of infection as in the treatment of a nasal deformity when it is necessary to chisel away some of the nasal bones and refracture them from the inside of the nose, and then use a cartilage implant to elevate the dorsum.

TECHNIQUE

For the correction of a defect of the frontal bone, the patient is anesthetized by the intratracheal nitrous oxide gas ether method. The hair is shaved well back of the forehead. A solution of novocain and adrenalin is injected for its hemostatic effect around the defect, if it is a large one. The incision is usually made above the hairline, in the eyebrow, or in an old scar if this seems advisable. The incision above the hairline may be just large enough to allow elevation of the skin and subcutaneous tissue over the defect or it may extend laterally to allow the turning down of a large forehead flap, thus exposing the entire defect. Cartilage is removed from the right side of the thorax. In selecting an area for the removal of cartilage, the site of the defect, its thickness, and extent determine from just what place the cartilage will be removed. The supraorbital ridges require a piece of cartilage the shape of which simulates their outline and while the surgeon shapes the cartilage to conform to the pattern, the first assistant closes the donor site.

Cartilage is usually built up on the lead patterns and the larger pieces are sewed together with fine silk. These are inserted through the incision above the hairline. At times, these may be fixed to the frontal bone with small pieces of stainless steel surgical needles used as tacks. Catgut sutures are used to close the pericranium over the graft, and the scalp flaps are approximated with fine interrupted silk sutures. A dressing of gauze that will provide pressure is applied and maintained for 10 days. At times, in the type of deformity that is frequently seen as a result of an automobile accident, the glabella and nose as well as the forehead may have to be built up. In this type of case the accurate fitting of the cartilage to form the bridge of the nose and the glabella is very important (Fig. 4). Little reaction, as a rule, follows insertion of cartilage and the cosmetic results in cases in which we have employed it have been very satisfactory.

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INTRATHORACIC GOITER

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IT is a curious coincidence that the first volumes of two famous medical journals, published in the years 1826 (Dubourg), and 1828 (Adelmann), respectively, should contain what were probably the first reported instances of death resulting from strangulation by, and malignant disease of, an intrathoracic goiter. Since that time, many cases have appeared in the literature, but it was not until the end of the last century that the condition was put on a familiar basis from the standpoint of pathology by Wuehrmann (1896), and that of diagnosis by Schiff (1899), one of the pioneers of roentgenology. Intrathoracic goiter is now sufficiently well known as a clinical entity for its presence to be considered in the diagnosis of every case of tumor of the upper mediastinum; yet, in spite of this apparent familiarity with the condition, a perusal of the literature will show that a considerable divergence of opinion exists in regard to the frequency of its occurrence. It would appear that the factor responsible for this irregularity is the lack of unanimity in the nomenclature which has been adopted for reference to the various clinical types. It is a matter of common experience, in operations for goiter, that, although the thyroid gland undergoes a general expansion in most cases, a good proportion of the enlargement may take place in a downward direction in a number of them. Indeed, it is probable that in almost half the cases one or other lobe dips down into the suprasternal notch, particularly in short necked people or in those in whom the thyroid gland occupies an abnormally low position (thyroptosis). At other times, the downward extension is more definitely retrosternal, but can be made to leave the thorax either by straining or coughing, or on extending the head. To this variety, the term "struma profunda" was applied by Kocher, and the title of intrathoracic goiter was reserved by him for those swellings of the thyroid gland in which some portion of the enlargement remained permanently retrosternal. The distinction was a good one, and Kocher's definition was accepted for general use. In the course of the following years, however, a further modification was introduced. The intrathoracic goiters were differentiated into two types, the partial and the total, according to whether the major part of the swelling was situated above or below the plane of the thoracic inlet. Some authors urge still further discrimination and would employ terms, such as lateral, median, pleural, subcervical, subclavicular, etc., in order to emphasize certain minor anatomical variations in particular cases. It is doubtful, however, whether the employment of so many descriptive terms serves any useful purpose, although the present system of classification leaves much to be desired. The term "partial," as employed at present, is satisfactory enough in that it means exactly what it implies; but it is not logical to apply the term "total" to a goiter which does not completely lie within the thorax. It is felt that this term should be reserved for those rare goiters in which the whole swelling lies within the chest, and that it should not be applied to those in which the major portion only is situated within the thorax, as is the present day custom. In the present series of over 1,200 thyroidectomy cases, there were no more than 3 to which the term "total" could justly have been applied, although there were 20 in which the major portion

From the King's College Hospital.

Fig. 1. Marked displacement of the trachea to the right. Case 8.

of the swelling lay within the thorax. In order to overcome this irregularity of classification, without the introduction of new terminology, it is suggested that those goiters which are mainly cervical but which also possess an extension into the thoracic cavity should never be called intrathoracic goiters, but should be referred to quite simply as cervical goiters with a thoracic extension. The term "partial" could then be applied quite justly and without reserve to those goiters in which the major portion of the swelling lies within the thorax and the designation of "total" or "complete" to those in which, for practicable purposes, the whole goiter is situated within the thoracic cavity.

THE FREQUENCY AND SEX INCIDENCE

The general range of figures in the literature relating to the incidence of this type of goiter runs between 5 and 45 per cent of all thyroid enlargements. The tremendous discrepancy in these figures makes it evident that those observers who experience the higher rate of frequency in their practice must of necessity include many instances of goiter among them that would not generally be regarded by the majority of operators as being intrathoracic in type. However, those observers who adopt Kocher's definition of intrathoracic goiter show a relatively constant frequency varying between 10 and 15 per cent. In the present series of 1,265 thyroidectomies, there were 111 cases in which some portion of the goiter was

Fig. 2. Photomicrograph showing a considerable degree of toxic hyperplasia. Case 1.

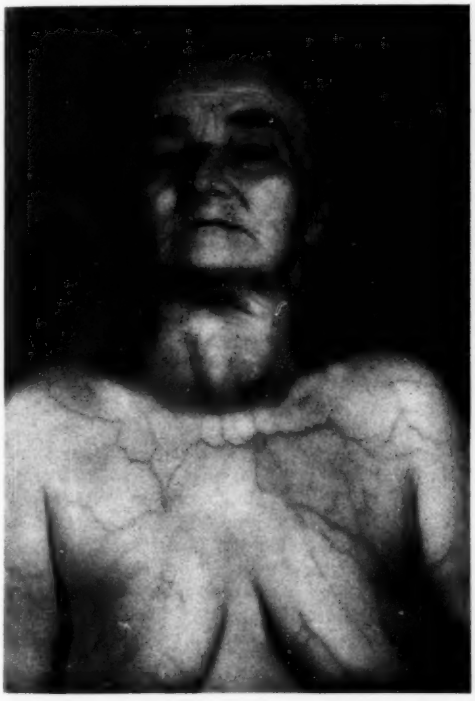

Fig. 3. Infra-red photograph showing dilated subcutaneous veins due to large substernal goiter. Case 19.

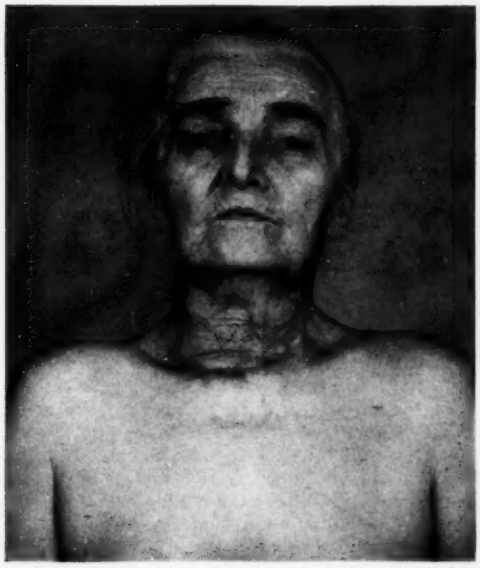

Fig. 4. Infra-red photograph taken 10 days after removal of large substernal goiter. The subcutaneous veins are hardly visible. Case 19.

Fig. 5. Toxic intrathoracic goiter; note distortion of the trachea. Case 2.

permanently retrosternal, a proportion of 8.7 per cent. Of this number, 91 were examples of cervical goiters with a permanent intrathoracic extension, 17 were cases in which the major portion of the swelling was situated below the plane of the thoracic inlet, and 3 were instances in which the whole swelling lay within the thorax. In the present day nomenclature, the 91 cases would be grouped as "partially" intrathoracic, and the 20 remaining as "totally" intrathoracic, a description which cannot be considered satisfactory because it is indefinite and not very accurate. It is proposed, therefore, not to regard the 91 cases of cervical goiters with permanent intrathoracic extensions as instances of intrathoracic goiters, so that the remarks in this article will refer solely to those goiters in which the swelling was mainly or wholly within the thorax.

In the literature, the frequency of the total variety, as we have outlined it here, is not given, but figures relating to combined numbers of total and partial intrathoracic goiters (using the terms in their limited sense) have been given by Curtis (1931) as being between 1 and 2 per cent, and by Crotti (1938) as between 3 and 4 per cent. In the present series, the percentage for a similar group works out at just under 1.6 per cent, of which proportion 1.34 and 0.23 per cent refer respectively to the partial and complete varieties.

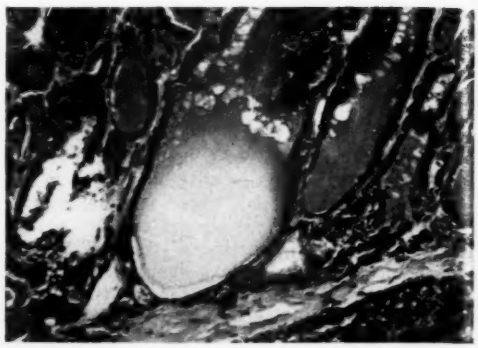

Fig. 6. Photomicrograph showing a moderate degree of toxic activity. Case 2.

With reference to the etiological factors of age and sex, it may be stated that they do not appear to be altered by the unusual situation of the goiter. In general, intrathoracic goiter is a disease of the middle aged woman. The specimens are usually of the nodular variety and are the seat of cystic or the other types of degeneration which tend to be common about that period of life. In the present series, 2 patients were 25 years old and 1 was 62 years of age, but all the ages of the remainder fell between the thirty-fourth and fifty-fifth years. Thus, the average age incidence was just over 40, a figure which is possible on the low side, but which may be related to the proportion of toxic cases in the series, comprising 7 of the total number of 20. Regarding the sex variations, there were only 2 men in the series, the proportion of females to males thus being 9 to 1. This ratio accords well with the general run of sex frequencies for goiters occurring about the same period of life. In regions of endemic goiter, the frequency of intrathoracic goiter tends to be higher than elsewhere, possibly owing to the greater number of large thyroids which occur in those districts; the sex and age incidence remain unaltered.

PATHOLOGY

The mode of production of an intrathoracic goiter is simple enough to understand, particularly in those cases in which a connection with the thyroid gland is retained. There is no doubt that the very great majority of thoracic goiters, including the total variety, are at one time or another cervical in position, and that downward growth is favored by the resistance of the cervical muscles anteriorly and laterally and by the trachea and vertebræ posteriorly. The line of least

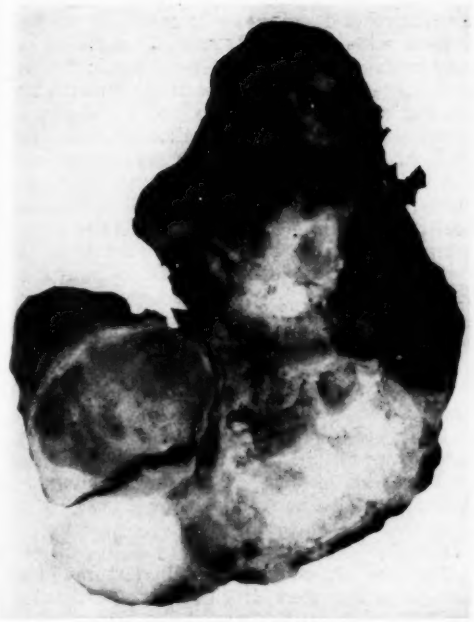

Fig. 7. Large substernal nodular goiter which showed a mild degree of toxic activity. Case 5.

Fig. 8. Photograph of intrathoracic goiter from Case 7. This specimen was mildly toxic. Actual size.

resistance is therefore downward, and the tendency to descent is also favored by the disposition of the infrahyoid muscles which serve as a guide into the mediastinum, and possibly also by the influence of actions, such as inspiration and swallowing, or by gravity. As the goiter progresses downward, its thyroidal connections become attenuated and no doubt in a few cases completely severed, giving rise to the totally intrathoracic type. An independent blood supply is, however, retained in these cases. The possibility of aberrant growth is, we consider, doubtful, although feasible. In the early stages of development, the thyroidal bud lies in front of the second aortic arch, coming later into contact with the aortic stem in the loose subpharyngeal tissue below the arches; thus the possibility of thoracic aberrant growth is a real one. Apart from surmise, however, there is no real evidence to support this theory, although Means (1938) mentions a case in which the goiter was resting on the diaphragm.

Intrathoracic goiter seems to originate with equal frequency from either of the lateral lobes or from the isthmus. When it originates from the latter, it usually deviates to one or other side as it grows in size. Bilateral forms also occur and may reduce the trachea to a narrow slit. Ordinarily, however, the trachea gets pushed to one

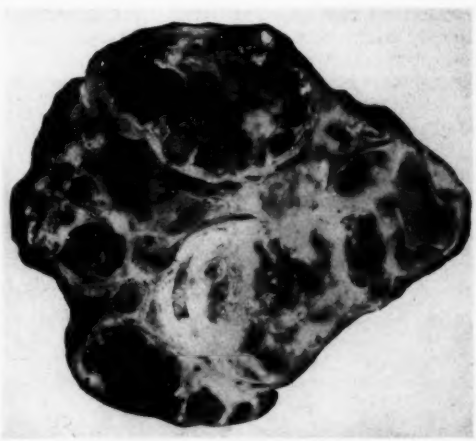

Fig. 9. Photograph of retrosternal non-toxic goiter removed from Case 15.

Fig. 10. Photograph of Case 20. A malignant adenoma.

side, becoming stretched over the swelling (Fig. 1); in rare cases, it may even describe a semicircle. The esophagus is affected to a lesser degree as it is less rigid and is situated more posteriorly. Occasionally, however, a goiter of this type may become retro-esophageal, particularly when it is located on the left side, giving rise to marked dysphagia.

Rarely, one encounters the "goiter plongeant," a variety first described by Malard in 1851. This type of goiter received its name from the curious way in which it bobbed up and down in the thoracic inlet, sometimes disappearing within the cavity and later being expelled vigorously during an attack of coughing or in swallowing (Case 10). It is usually accompanied by much more subjective disturbance than the other varieties, particularly with what is usually called "choking spells," and is, therefore, more likely to produce a fatal result on that account. Once the goiter has become intrathoracic its retention is favored by further growth, or by the development of degenerative changes, or by a hemorrhage. In a small percentage of cases, probably between 2 and 3 per cent, malignant disease supervenes. Case 20 is illustrative of this phenomenon. When the gland is the seat of toxic changes, the character of these is of the usual type but milder in degree, showing an uneven spread of activity. One case in the series, however, showed changes which were typical of a very active toxic gland (Fig. 2).

SYMPTOMATOLOGY

Toxicity. Although the main features of all intrathoracic goiters depend upon the development of pressure effects on the structures which pass through the thoracic inlet, there is no doubt that there exists in a certain proportion of them an associated thyrotoxicosis. There is little reference in the literature to this side of the question and the reason for this apparent oversight may be that the toxic manifestations are often mild in degree and are due in part to a coincident increased activity of the normally situated thyroid gland. In such cases, the symptoms are allevi-

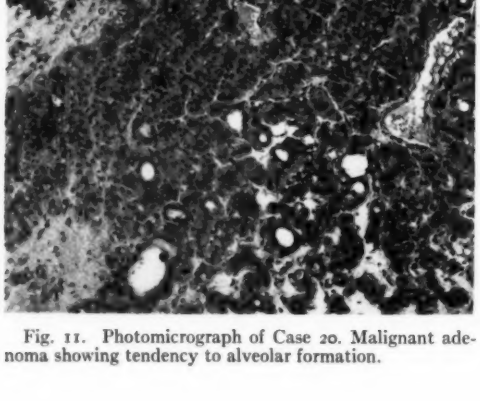

Fig. 11. Photomicrograph of Case 20. Malignant adenoma showing tendency to alveolar formation.

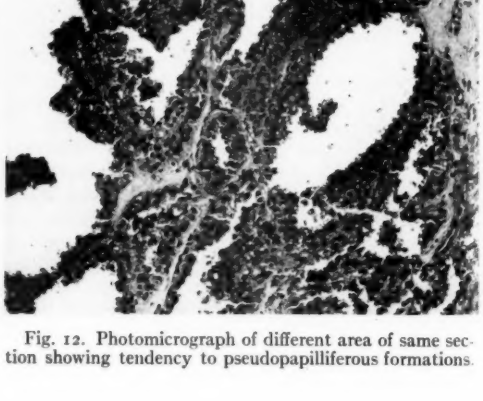

Fig. 12. Photomicrograph of different area of same section showing tendency to pseudopapilliferous formations.

SUMMARY OF CLINICAL SIGNS AND SYMPTOMS—20 CASES

	Toxic							Non-toxic											Carcinoma	Percentage
Case	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	
Age	35	47	49	37	39	32	45	37	35	42	42	34	25	49	55	25	34	42	62	52	
Sex	F	M	F	F	F	F	F	F	F	F	F	F	M	F	F	F	F	F	F	F	
Cervical thyroid enlargement	−	+	++	+	++	+	+	−	+	+	−	+	+	+	+	+	+	+	+	+	85
Loss of weight	++	++	++	+	+	+	−	−	++	−	−	−	−	−	−	−	−	−	−	+	40
Toxic symptoms	+	++	+	++	+	++	+	−	−	−	−	−	−	−	−	−	−	−	−	−	35
Nervousness	−	−	++	+	++	++	++	−	−	−	+	+	+	−	−	+	+	−	−	−	50
Dyspnea	++	+	−	+	++	−	−	+	+	++	+	+	+	+	+	+	+	+	+	+	85
"Choking" spells	−	−	+	−	+	−	+	−	−	++	−	−	+	−	−	+	+	−	−	−	35
Cough	+	+	−	−	−	−	−	++	−	−	−	−	−	+	−	−	+	−	+	+	35
Stridor	−	−	−	−	−	−	−	−	+	−	−	+	−	−	−	−	+	+	−	+	25
Cyanosis	−	+	−	−	−	−	−	−	−	−	+	−	−	+	−	−	−	−	+	−	20
Dysphagia	−	−	−	+	+	−	−	−	+	−	−	−	−	−	+	−	−	+	−	−	25
Venous congestion	+	−	+	−	−	−	−	−	+	−	++	+	−	+	+	−	−	−	+	+	45

ated by, or disappear after, a thyroidectomy, or the operation may appear not to have been completely successful. In other instances, the toxic manifestations are well in evidence, but are overshadowed by the greater prominence of the mechanical features. The degree of toxicity is, however, usually low, because an intrathoracic goiter is often the seat of various types of degenerative processes and, therefore, does not tend to lend itself well to the development of a functional hyperplasia. But, occasionally, it may be the center of a typical toxic characterization without any coincident enlargement of the thyroid gland, as happened in Case 1 in which the diagnosis of phthisis was made. In the present series of 20 cases, there were 7 patients who were clinically thyrotoxic. In 1 of these, the goiter was completely intrathoracic with no apparent enlargement of the thyroid gland, although subsequent examination of that portion of the gland which was removed along with the goitrous swelling, showed that it was the seat of a coincident hyperplasia. Of the 6 remaining cases, there was slight enlargement in 2, moderate enlargement in 4.

The symptoms appertaining to the toxic state are of that lesser degree of severity which is the general rule with nodular goiters. The signs of toxicity, as evidenced by loss of weight, myasthenia, exophthalmos, thirst and amenorrhea are, as a rule, slight, although loss of weight may be more noticeable in those cases in which difficulty in swallowing is a feature. The symptoms commonly present consist of tachycardia and palpitation, sweats, tremors, increased nervousness, and emotional instability. This group of symptoms we regard as evidence of autonomic overactivity and an accompaniment not necessarily indicative of thyroid overactivity. It was present in some of the non-toxic cases, particularly in those patients who were subject to dyspnea on exertion, or were troubled with the menopause. Exophthalmos was seen in only 1 patient (Case 6) and was moderate in degree. The basal metabolic rate was raised in each of the patients, the average increase being +30; in 1 patient it was over +40.

Pressure effects. The early manifestations of pressure are usually referable to the respiratory system, owing to the close attachment of the swelling to the trachea. Dyspnea on exertion is probably the earliest and most frequent of these symptoms and is due to the diminished respiratory exchange, an effect which is consecutive to the narrowing or flattening of the trachea or to its dislocation from the midline. It may be present for some months or years without having given rise to much disturbance or without getting very much worse. As a rule, however, it progresses steadily *pari passu* with the distortion of the trachea and may ultimately pass into a more or less continuous form of breathlessness. At other times, the process may be more acute and attacks of asthma may be simulated, becoming associated in long standing cases with chronic bronchitis and emphysema. Indeed, this asthmatical simulation is so real that the possibility of intrathoracic goiter should be borne in mind in the diagnosis of

every case of asthma which commences in middle life. Another type of respiratory disturbance, which is not uncommon, but which is also very typical of the disorder, is that which is referred to by the patient as a "choking spell." This consists of an attack of acute dyspnea which is always very distressing and may be fatal. It is due to respiratory obstruction and is often precipitated by a twist of the head or similar movement, or on lying down, so that the patient after a time learns to avoid those movements, or that position, which experience teaches him are liable to produce an attack. Sometimes, the patient is affected during sleep and may die from suffocation without recovering consciousness. The "goiter plongeant," is very apt to be associated with "choking spells" because of likelihood of the swelling to become impacted in the thoracic inlet during one of its periodic excursions. In the present series of 20 cases, there were 17 instances of dyspnea, 7 of which were subject to "choking spells," and one was an instance of "goiter plongeant." Cough is another symptom which, although less frequent, may become very pronounced. It is usually of a dry nature and is due to an inability to expel a small collection of mucus which lodges behind the obstruction. Occasionally, it may be the sole symptom for some time as in Case 8, in which a diagnosis of phthisis was made; but more often, it is found in association with dyspnea. The combination of dyspnea, cough, and cyanosis may give rise to the view that the patient is suffering with heart disease, Case 14. Cough was a noticeable symptom in 7 patients of present series.

Stridor was noticed in 5 cases and was due apparently to a narrowing of the trachea, but it may also be due to a loss of power of the laryngeal abductors. In these cases, the cough would probably take on the brazen character which is so characteristic of certain aneurisms of the aortic arch. When the narrowing is due to pressure, it may be so extreme that the airway becomes almost completely occluded. In 1 case in the present series, it became necessary as a life-saving measure to establish an immediate air passage. This was done by passing a catheter under bronchoscopic vision through the obstruction, when it was found that only the smallest size tube available would pass, so that pure oxygen had to be administered while the patient was being prepared for immediate operation. However, a minor degree of weakness of the recurrent laryngeal nerve, insufficient to give rise to symptoms, is by no means uncommon. This is really only to be expected as it is found in some 10 to 15 per cent of normally situated goiters, and it is on this account that many surgeons consider it a good practice to examine the larynx in all patients requiring thyroidectomy. The presence of hoarseness or inspiratory stridor would definitely suggest the possibility of such a complication, but this was not noticed in our cases. The frequency of nerve involvement has been placed as high as 25 per cent (Higgins, 1927). One instance has been recorded of bilateral recurrent laryngeal nerve palsy.

Next to a disturbance of the respiratory tract, it would appear that the esophagus is the most frequent organ to suffer. Dysphagia occurs about as frequently as cough. It is not severe as a rule, except in those cases in which the goiter insinuates itself between the trachea and the food tube, or, more rarely, passes behind the latter structure which would then be compressed simultaneously from the front and rear. This complication is seen more commonly in the cervical type of goiter, particularly when it is situated upon the left side, but it may also occur with the intrathoracic type. In a case of this sort, the food tube may rarely sustain a sharp kink or bend, the clinical and x-ray pictures suggesting the presence of an esophageal diverticulum. Dysphagia may, however, become a prominent feature when the goiter is complicated by the development of a malignant change.

Pressure on the venous return may also be a marked feature in certain cases. A retardation or definite obstruction to the flow of blood from the upper part of the body is shown by the presence of large veins in the neck and, in advanced cases, a marked suffusion of the head and neck. The pressure may be most marked on the superior vena cava, when the goiter is deeply placed, but more often one or other of the innominate veins suffers the most, leading to distention of one or both jugular veins, and in severe cases to cyanosis, and even edema of the face. In most cases, however, a mild degree of venous obstruction is always present and is usually quite visible to infra-red photography (Fig. 3), although much less so to the naked eye. Other features which may be regarded as clinical rarities occur in the course of an intrathoracic goiter and are the effects of pressure on the thoracic duct, giving rise to chylothorax, inequality of papillary contraction from disturbed sympathetic innervation, and alteration of the pulse pressure. None of these rare features occurred in any of the present series.

DIAGNOSIS

In most cases this should not be difficult if the possibility of the condition is borne in mind. The frequency of the totally intrathoracic goiter is

very low, and, therefore, all other cases will show a cervical enlargement which should form a clue to the nature of the condition. The development of dyspnea in a woman with a goiter, particularly if associated with a feeling of pressure behind the sternum, is very suggestive; or the onset of acute attacks of shortness of breath with cough, dysphagia or venous congestion of the head and neck is equally characteristic. The points to be noted upon examination are the position of the trachea, whether centrally placed or deviated from the midline; ptosis or fixity of the larynx; inability to palpate the lower pole of the thyroid, a maneuver which should be quite practicable when the head is flexed. Its presence should be suspected in cases of thyrotoxicosis when the thyroid gland is not much enlarged in proportion to the degree of activity suggested by the symptomatology and also in those cases of asthma which develop in middle life or are associated with unusual clinical features. The employment of roentgenology as an aid to diagnosis is almost indispensable for the confirmation of the diagnosis and for the differentiation of conditions, such as Hodgkin's disease, aortic aneurism, thymic enlargement, and other tumors of the upper mediastinum, which are likely to give rise to difficulty in diagnosis.

OPERATIVE TECHNIQUE

As the type of pathological change present in the intrathoracic goiter is not one that lends itself to improvement by x-ray therapy, removal should be advised in every case. The operation presents no great technical difficulty and can be performed under local anesthesia. Those operators who employ this type of anesthesia consider that it avoids the risk of respiratory embarrassment at the time of operation and lessens the chance of postoperative complications of the respiratory tract. It is a debatable point, however, whether this statement is fundamentally sound because, in a bad case, much respiratory embarrassment may already exist and this is often greatly increased by the manipulations due to the operation. In the present series, it was found that the most satisfactory type of anesthesia was obtained by means of an intratracheal tube long enough to pass below the obstruction, the exact position of which could be ascertained by means of the bronchoscope. Apart from ensuring adequate respiratory exchange during the period of anesthesia, this method has the additional advantage in that the tube serves as a guide to the position of the trachea, a point about which it is important to be sure. At the same time, if the sternum should require to be split (this was not necessary in any of present series), the procedure would occasion no further inconvenience to patient.

The usual type of collar incision was employed in all cases and was found to be sufficient for the purpose. In general, the first step of the operation dealt with the ligature of the main arteries to the gland, because it is known that the intrathoracic portion derives its blood supply from these vessels. It is usually simple enough to ligate the arteries to the upper pole, but the inferior thyroid arteries are often not so accessible, as they may be buried beneath the mass of goitrous enlargement. However, having effected the control of vascular supply as far as was possible, the next step consisted in the resection of the cervical portion of the lobe from which the goiter appeared to originate, so as to enable the inferior thyroid arterial supply to be controlled more effectively. Any connection of tumor with the opposite lobe was also divided before the attempt at enucleating the swelling was made. In this way the main blood supply to the goiter was controlled, but further efforts were made to avoid the possibility of hemorrhage by removing the tumor *in toto* rather than piecemeal, and by taking care to remain within the capsule of the goiter. It was found that in many cases the best way to accomplish this was by the use of the index finger which would be inserted laterally or behind the tumor and worked downward into the thorax. By this means it was possible to reach the lower end in about half the cases; but in the remainder this was not possible and blunt dissection by means of small pledgets of gauze was used instead. In some cases, however, it became necessary to employ traction. The danger in pulling is, of course, the possibility of tearing an artery, so that care must be taken to see that it is carried out as gently as possible and that advantage is taken of any small bands of fascia which may be found to be attached to the goiter. At the same time the danger of rupturing or perforating the softened trachea and the close proximity of the recurrent laryngeal nerve on the left side must be borne in mind. Possibly, in a difficult case, it might be preferable to split the sternum rather than risk removing the goiter in pieces, but, as has been stated, this maneuver was not necessary in the present series, even in connection with the three goiters which were completely intrathoracic. If it should become necessary to split the sternum, the gap in the bone should be wedged so as to secure the maximum benefit from the measure. The control of hemorrhage was effected by means of packing, a method which was particularly effective if employed within the confines of the capsule.

In one of the totally intrathoracic cases, the deep attachments of this layer were clamped off and ligatured, as is sometimes done in the removal of a thymic tumor. After the swelling had been removed, the cavity was inspected by means of a good light and all bleeding points were sealed off with the cautery. Drainage was used in all cases for 24 hours, the cigarette type of drain being the most useful.

Postoperative complications. After the control of hemorrhage, the most immediate danger consists of the collapse of the trachea, a complication which is liable to follow any operation for goiter, but especially the intrathoracic type, on account of the degree of distortion and compression to which the trachea has been subjected. As the area of collapse may arise within the thorax, a tracheotomy may not always be effective unless the means to intubate through the tracheal opening are also available. Other possible complications are the occurrence of mediastinitis, tracheal or esophageal fistula, laryngeal nerve palsy, and secondary hemorrhage. At the same time, a thyroid crisis may supervene if the patient is toxic. There were no deaths in the present series of intrathoracic goiter, although there were 10 deaths in the total series of 1,265 thyroidectomies.

SUMMARY

1. The suitability of the terms "total" and "partial," as at present applied to intrathoracic goiter, is questioned. In present day usage the term "total" is applied to that type of goiter in which the greater portion of the swelling is situated within the thorax, and the term "partial," to that in which the larger portion lies outside the thorax. With this nomenclature it follows that many goiters will be referred to as "total" which, in point of fact, are not strictly so, and others will be referred to as "partial" which are mainly cervical, but which possess a small extension into the thorax. To overcome this difficulty it is suggested that the term "intrathoracic" should be reserved for those goiters in which the whole, or the major portion, lies within the thorax and should not be employed to describe those which are mainly cervical in type with a permanent retrosternal extension. This limited application would permit the distinction between "total" or "complete," and "partial" or "incomplete" to be made with fairness and accuracy.

2. In a series of 1,265 thyroidectomies, there were only 3 instances in which the goiter lay entirely within the thorax, and 17 in which the major portion of the goiter was intrathoracic. These proportions are equivalent respectively to 0.23 per cent and to 1.34 per cent. There were 91 cases in which some portion of the swelling was permanently retrosternal; but as these were cervical in type, their data have been excluded from this article.

3. Of the 20 cases which were thought to be intrathoracic, the operation specimen was examined in all. It was found that the pathological changes did not appear to differ greatly from those which are found in cervical goiters about the same age period. In general, the toxic variety appeared to show, with one exception, only a mild degree of activity, and the nodular variety seem to be disposed to show a more advanced degree of those types of degeneration which are not uncommon in that type of goiter.

4. There were 7 cases in the series in which definite manifestations of toxicity were evident. One of these was completely intrathoracic, and 4 others showed only a slight enlargement of the thyroid gland. This proportion, 30 per cent, approximately, suggests that the frequency of these toxic cases may be higher than is commonly imagined but that their manifestations are overshadowed by their more prominent mechanical effects. It also permits one to suppose that certain cases of thyrotoxicosis, persistent after a thyroidectomy, may be dependent in a small proportion to the presence of an active intrathoracic extension.

5. The most constant feature was dyspnea, and the most characteristic, the occurrence of a "choking spell." The former was noticed in 85 per cent, and the latter in 35 per cent. Other effects which were dependent mainly upon pressure on the trachea, the esophagus, or the cervical veins, were present in about equal proportions.

6. Treatment was straightforward and did not involve a splitting of the sternum in any of the cases. There were no postoperative complications and the patients did well in all.

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THE TREATMENT OF CARCINOMA OF THE COLON IN SMALL HOSPITALS

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THIS report is submitted for the purpose of analysis and study of cases of carcinoma of the large bowel treated surgically in an open staffed small general hospital and to make a plea for group study and treatment in the hope of improving mortality statistics. The study covers a series of 49 cases of carcinoma of the large bowel, treated over a period of 10 years. It is obvious that this study, when compared with reports from larger clinical centers where colon surgery is under the control of a small specialized group, has no value except disclosure of end-results in such cases when patients are treated in the small hospitals.

The literature concerning surgery of the colon is shockingly barren of studies of this type with a few exceptions: P. C. Morton, W. F. Gemmel, C. Rosser. The writer feels that in the small general hospital there is great and urgent need for improvement in the care offered to the patient with colon cancer. It is only too obvious that he is not getting the same opportunity as is the more well-to-do patient (or indigent) in the large clinical centers.

Clinical analysis. The series of cases analyzed comprised 49 in number, and the patients were treated over a 10 year period by 11 different surgeons. A statistical break-down of this small series discloses nothing that has not been previously reported as regards distribution, age, incidence, and previous symptoms as elicited from the past history. An analysis of the past histories discloses the usual incidence of previous treatment for hemorrhoids and a high percentage of previous abdominal operations.

Surgical management. The thoroughness and adherence to detail of the pre-operative management appears to have been grossly influenced by the economic restrictions imposed by the cost of hospitalization. The average number of days of pre-operative preparation was 4.3 days. Pre-operative peritoneal vaccination was used in 3 cases. No doubt the delay on the patient's part in seeking surgical aid for carcinoma of the colon has been influenced by economic factors in the same manner in which there has been a 29 per cent increase in surgical delay in appendicitis. This has been pointed out by Kelly.

In the series there were 28 elective operations performed. Eleven patients died within 16 days of operation, a mortality of 38 per cent. Peritonitis, cardiac failure, pulmonary embolism, surgical shock, and pneumonia were stated causes of death, in order of decreasing frequency. Nine were discharged from the hospital. Three were untraceable. One lived 2 years; 1, 14 months; 4, less than 1 year. Generalized metastasis caused the death of 5. Intestinal obstruction is reported as the cause of death of the other traceable cases. At the time of this study, 2 had survived 5 years; 2, 4 years; 2, 3 years; 2, 1 year. At the end of the 3 years, 6 patients were living and well, 35 per cent.

Eight patients were admitted to the hospital with acute intestinal obstruction. Laparotomy was done within 24 hours with a 62.5 per cent mortality, death being caused by peritonitis and obstruction, or peritonitis alone. It is in this latter group, that the writer feels there could be the greatest improvement in pre-operative management, namely, non-surgical decompression maneuvers with the Wangensteen apparatus or the Abbott-Johnson intestinal tube. Particular attention should be directed toward establishing the water balance of these dehydrated people. The situation is seldom sufficiently urgent to preclude the determination of the carbon dioxide combining power of the blood. The chloride level can easily be brought to normal by the administration of ½ gram of sodium chloride per kilogram of body weight for each 100 milligrams that the blood plasma chloride level has been depressed (1). Of the greatest importance is the use of blood transfusions before operation.

In 11 elective operations upon the left colon, 7 different types of surgical procedures were attempted. Thirty-six per cent died within 16 days. In 8 elective operations on the right colon, 6 different types of surgical procedures were carried out with an immediate postoperative mortality of 65.5 per cent. Twelve different types of surgical procedures were done in elective operations on 6 patients with carcinoma of the rectum. Two died within 16 days of operation, a 33.3 per cent mortality. Four died within one year, a 65 per cent mortality.

Six patients with rectal carcinoma were treated by radiotherapy. One patient died of peritonitis following perforation of the rectum by the radium applicator. One died of arteriosclerotic heart disease 16 days after radiation therapy was begun. One is not traceable and the other died within 3 years. The immediate posttherapy mortality was 16 per cent, a probable 100 per cent in 3 years.

In this particular type of hospital, any attempt on the part of the attending surgeon to advocate a group study and a careful pre-operative preparation, is often interpreted by the patient and more frequently by the relatives, as a "loading up" maneuver "to milk the patient of money." It is obvious from this conception on the patient's part that the average standard of care in Detroit is reflected and the surgeon's attempt to offer them something better is misinterpreted. Not the least important among the factors retarding solution of this problem is the lack of co-operation and esprit de corps among the staff members.

That the enviable mortality statistics of the larger clinical centers are the direct result of specialized management is quite evident. One hundred colon resections at the Mayo Clinic were carried out with a mortality of 16.21 per cent (5). Eighty-five colon resections were performed at Peter Bent Brigham Hospital with a mortality of 17.5 per cent (5). No improvement can be expected in the small hospital field until one qualified surgeon who is particularly interested in colon surgery, is permitted to treat or at least supervise the treatment of all patients with cancer of the colon, who come to the hospital for treatment by the staff. The occasional operator should not be tolerated.

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RESULTS OF TREATMENT IN ACUTE APPENDICITIS

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THE treatment of acute appendicitis is not a closed issue. It is generally agreed that immediate appendectomy is indicated in early non-ruptured acute appendicitis. However, opinion is divided in regard to the question of surgery in the ruptured appendicitis case. Some favor immediate operation in any stage of the disease, while others do not believe in operating when there is diffuse peritonitis.

In order to answer this and other questions, we have studied the results of cases at the University of Nebraska Hospital for the 7 years, 1932 to 1938, inclusive, and from the private practice of one of us (H.H.D.) from 1928 to 1938. At the University Hospital there were 650 cases, 117, or 18 per cent, of which were ruptured when first seen. In the private practice there were 313 cases, of which 62, or 20 per cent, were ruptured when first seen. This made a total of 963 cases of acute appendicitis studied. So called chronic appendicitis and subacute appendicitis were not included in this study.

Acute appendicitis may be classified as follows: (1) non-ruptured, (2) local spreading peritonitis, (3) diffuse peritonitis, (4) abscess, and (5) moribund.

Group 1, non-ruptured. Of the non-ruptured cases there were 252 in private practice and 532 at the University Hospital, totalling 784. The mortality was 2 in each group, or 4 deaths in all, which was a mortality of 0.5 per cent.

GROUP 1.—NON-RUPTURED

	No.	Deaths	Per cent
Private	252	2	0.8
University	532	2	0.4
Total	784	4	0.5

If every patient with appendicitis were operated upon before rupture, the mortality of the diagnosable cases would be held down to approximately the figure in this group, 0.5 per cent. Therefore, the campaign both to the public and to the medical profession for early operation should be vigorously continued.

Group 2. Local spreading peritonitis. This group included the early ruptured cases with tenderness confined to the lower right quadrant of the abdomen in which, at time of operation, an exudate was found near the appendix and sometimes in the right lumbar gutter and/or in the pelvis. Most of these patients were in the second day of the attack, a fair number were in the third day, and a few were in the first 24 hours. These patients usually had a temperature of 100 to 102 degrees and had more tenderness and rigidity than the non-ruptured cases. These signs also covered a little larger area but were still confined to the lower right abdomen. These were the early ruptured cases and at times it was difficult before operation to be sure whether the appendix had ruptured or not.

GROUP 2.—LOCAL SPREADING PERITONITIS

	No.	Duration	Hospital stay	Temperature	Leucocytes	Deaths	Per cent
Private	34	2	19	100.5	21,500	2	6
University	59	2.2	22	100.8	17,880	3	5.1
Total	93	2.1	21	100.7	18,940	5	5.4

Treatment consisted in appendectomy without drainage in 3; appendectomy with drainage in 79; and drainage only, with appendectomy later in 3.

Deaths in private cases were due to secondary hemorrhage in 1 and pulmonary embolus in 1; in the University Hospital cases were due to diffuse peritonitis in 3 instances.

Of the 34 private cases in group 2 there were 2 deaths, but neither was due to peritonitis. One patient whose operation was performed out of town died on the sixteenth day of secondary hemorrhage, and the other on the tenth day of a pulmonary embolus. Of the 59 University cases there were 3 deaths. They were all due to spreading peritonitis.

The most common treatment was appendectomy with drainage. The peritonitis completely disappeared in all but 2 of the surviving cases, each of which developed an abscess that had to be drained.

Group 3, diffuse peritonitis. The most serious cases were those of group 3. Most of these were seen between the third and fifth day of their attacks, although they occasionally arose a day or two before or after this time. The conditions in these cases were much more severe. Commonly the temperatures were 102 to 105 degrees, the leucocytosis averaged 21,000, tenderness and rigidity extended beyond the lower right abdominal quadrant, and the general appearance was typical of peritonitis cases.

The method of treatment in this group is debatable. Some surgeons advise immediate operation while others do not operate until the symptoms clear up entirely, later draining the abscess. At the present time probably the majority of surgeons are operating in these cases as soon as possible after they first see them, but there is an increasing number who delay operation at this stage of the disease.

In studying the diffuse peritonitis cases, we have divided them into those with early operation and those with delayed treatment. Up to 1933 it was the practice of one of us (H.H.D.) to operate immediately at this stage. In this group were 11, 8 of whom died, a mortality of 73 per cent. Since then with delayed operation he has had 7 cases with only 1 death, a mortality of only 14 per cent. The patient who died had a questionable diagnosis as there had been a much more acute onset and much more rigidity than was usual for appendicitis. However, as autopsy was not done, it seemed only fair to include this case in the statistics. The University group, treated with immediate operation, had 2 deaths in 6 cases, a mortality of 33 per cent. With delayed operation, on the other hand, there was 1 death in 7 cases, a mortality of 14 per cent. Taking both groups together, the mortality with immediate operation was 60 per cent, and with delayed operation it was only 14 per cent.

GROUP 3.—DIFFUSE PERITONITIS

Immediate Operation

	No.	Duration	Temperature	Leucocytes	Deaths	Per cent
Private	11	4	102.1	24,050	8	73
University	6	3	102.2	18,620	2	33
Total	17	4	102.1	21,970	10	60

Delayed Operation

Private	7	3½	102.8	20,100	1	14
University	7	4½	102.4	20,610	1	14
Total	14	4	102.6	20,450	2	14

Of the 10 deaths following immediate operation, all were due to peritonitis, and in at least 3, there were metastatic infections, showing that there had been septicemia.

When we speak of delayed operation in these cases, we do not wish to imply that this improvement of results can be obtained simply by letting the patient alone. The details of management are exceedingly important. The gastro-intestinal tract is given absolute rest and is decompressed by use of gastric suction. The fluid balance is carefully maintained. We no longer fear giving sedatives as it has been shown that morphine does not increase distention and actually stimulates peristalsis. All of these patients, after recovering from the peritonitis, are sent home with instructions to return in 10 weeks for subsequent appendectomy.

Of these 7 cases with delayed operative treatment, 1 died, 4 developed an abscess that had to be drained, and 2 recovered without residual abscess. However, in one of these two, because of too early operative intervention, infection was started up again, and a pelvic abscess developed later. In view of this case and one other in which appendectomy was done a little too early after peritonitis, we definitely advise waiting at least 2 months and preferably 10 to 12 weeks before performing subsequent appendectomy. In only one of these cases was the appendix found sloughed away. In the remaining cases it was a definite menace. Therefore, although we recognize that an occasional appendix will be destroyed by the inflammation, it seems best to advise appendectomy in all patients 10 to 12 weeks after the acute attack.

Concurring with the experimental work on peritonitis, these results indicate that delayed operation is the treatment of choice in diffuse peritonitis. It has been thought in the past that, even though the mortality was high, we should operate to give the patient his only chance. We must change our views and realize that "masterful inactivity," as Deaver has expressed it, will save many of these lives. In other words, there is a mortality of treatment as well as a mortality due to the disease.

Group 4, abscess. Localized abscess if present usually occurs after the sixth or seventh day of the disease. The cases included in this group for statistics were those in which patients had this condition on admission. In addition there were those of the diffuse peritonitis group which later developed abscess. A pelvic abscess was suspected if, after some improvement, the temperature and leucocytosis rose, a diarrhea developed, and a mass could be felt by abdominal, vaginal, or rectal examination. If the condition grew worse with no discernible abscess, a fluoroscopic examination or x-ray plate was made to discern the possibility of a subphrenic abscess. If found in the right posterior area, the usual location in these cases, it was drained by resecting the right twelfth rib and opening the space extraperitoneally at one stage, the procedure which has been described by Alton Ochsner.

GROUP 4.—ABSCESS

	No.	Duration	Hospital stay	Temperature	Leucocytes	Deaths	Per cent
Private	8	8	29	100.4	26,900	0	0
University	42	9	23	100.5	18,500	4	9.5
Total	50	9	26	100.5	19,900	4	8

Treatment consisted of appendectomy, with drainage in 32 cases with 3 deaths, and drainage only in 18 cases with 1 death.

Of the 50 cases of abscess studied, there were 4 deaths, all in the University Hospital series. In 3 of these an appendectomy was done as well as drainage. In 2 of these 3, the breaking down of the abscess wall to reach the appendix resulted in spreading the infection and producing a fatal diffuse peritonitis. We advised, therefore, to open the abscess extraperitoneally and not to remove the appendix unless it was easily accessible and the abscess wall was not broken through by the procedure. An abscess at the right lumbar gutter could be approached by a McBurney incision, the mass found before the peritoneum was opened, and then the peritoneum opened where the mass was in contact with it. A pelvic abscess could be drained through the vagina or rectum. If an incision was made and no abscess found, the peritoneum was opened and the abdomen was explored carefully and gently. If an abscess was then found, the incision could be closed and another one made in a location to reach the abscess extraperitoneally.

Group 5. Moribund patients. No discussion of the moribund cases is necessary. Four of the 5 cases were at the University Hospital. Needless to say, all of the patients died irrespective of treatment.

SUMMARY CHART

Group		Average duration	Treatment advised	No.	Deaths	Mortality per cent
1	Non-ruptured	1	Appendectomy	784	4	0.5
2	Local spreading peritonitis	2.1	Appendectomy with drainage	93	5	5.4
3	Diffuse peritonitis	4	Immediate operation	17	10	60
			Delayed operation	14	2	14
4	Abscess	9	Drainage	50	4	8
5	Moribund	12	Supportive	5	5	100
	Total			963	30	31.1

SUMMARY AND CONCLUSIONS

1. The commonest causes of death in acute appendicitis are purgation and procrastination.

2. A statistical study is given of 179 cases of peritonitis, secondary to acute appendicitis.

3. A patient with a non-ruptured acute appendicitis, usually seen in the first day or two of the attack, should have immediate appendectomy.

4. The patient with local spreading peritonitis, usually seen on the second day, or occasionally on the first or third day, should have immediate appendectomy. Most surgeons also use drainage.

5. In patients with diffuse peritonitis, most commonly seen from third to fifth day, it was found that in those treated by immediate operation, mortality was 60 per cent, while in those treated by delayed operation it was only 14 per cent.

6. Abscess, which usually takes 6 or more days to form, is best treated by drainage, care being used not to break down the abscess wall and thus produce a diffuse peritonitis.

INFECTED ECTOPIC PREGNANCY

Infected Pelvic Hematocele

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SUPPURATION complicating ectopic pregnancy has long been recognized as a clinical entity. During the last century this complication seems to have been frequent. With the advent of immediate surgery in ectopic pregnancy, it has become rare; that it has not entirely disappeared is evidenced by the fact that 10 cases of infected pelvic hematocele have been seen on the wards of a large city hospital and in private practice by the senior author (H. C. F.) within the past 8 years.

In contrast with the rather full discussion found in the older text books, many of the modern books do little more than mention that this complication may occur and advise colpotomy as the treatment of choice. A number of case histories have been published.[1]

Lawson Tait, in 1888, did much to clarify the syndrome of pelvic hematocele by insisting that it was always secondary to ectopic pregnancy. While definite or presumptive histological evidence of extra-uterine pregnancy is present in only 5 of the 10 cases of infected hematocele to be reported, it is felt that probably all of them illustrate suppuration occurring in ectopic pregnancy. Inasmuch as the underlying pathology of the two conditions is essentially similar, i.e., infection of encysted blood with or without a fetus, it is believed that until a larger number of cases are observed, the two may be conveniently discussed together, particularly from the viewpoint of diagnosis and management.

ETIOLOGY AND PATHOGENESIS

It is not pertinent, at this point, to present a concept of the etiology of ectopic gestation as this has been discussed elsewhere (11). Of interest, however, is the origin and the pathogenesis of the infection. Lawson Tait voiced the opinion of the gynecologists of his era when he stated that almost all cases of suppuration in tubal pregnancies occurred in those which had ruptured into the broad ligament. He described one instance of suppurative intraperitoneal ectopic pregnancy, but believed it to be rare. Berry Hart, in 1893, described two autopsy cases in which sagittal sections apparently confirmed Lawson Tait's view. The explanation advanced was that the gestational sac was closely applied to the rectum without any intervening peritoneum, and therefore, organisms could easily pass from the rectum to the hematoma, thus causing essentially an extraperitoneal abscess. This view has been carried down in most of the monographs of today, but it is probably an infrequent pathway of infection. Intraligamentary rupture occurs so infrequently (33) that it seems difficult to account for all cases of suppuration in this manner.

Secondary infection from the intestines may produce abscess formation in an intraperitoneal hematocele. Although this is difficult to prove, the recovery of intestinal flora—colon bacilli, staphylococci in cultures taken from the infected hematocele is highly suggestive (Cases 3 and 6). Infection with the typhoid and paratyphoid bacillus has been reported (1, 26). Infection by the gonococcus may be responsible (Case 10). Tubal pregnancy usually occurs during the chronic or healed phase of salpingitis—"follicular salpingitis." However, ectopic pregnancy may occur during a healing salpingitis, although the gonorrheal inflammation has not yet entirely subsided (16).

In Cases 1 and 8 a history of recent uterine interference performed at another institution was obtained. Inasmuch as all uterine cavities are infected following a curettage, and because of the time relationship, it seems fair to assume that the curettage was the unwitting source of infection. Although the history of manipulation was elicited twice, it probably occurred more often. At Harlem Hospital, evidence of attempted abortion is often found in ruptured ectopics. *Intra-uterine manipulation is probably the most important single source of infection in a suppurating pelvic hematocele.* In this series there was no instance of infection secondary to a bacteremia.

SYMPTOMATOLOGY

The symptoms are compatible first with an ectopic pregnancy, followed later by signs of sup-

[1]These case histories are found in references 2–8, 12, 15, 17–20, 23–25, 27, 31, 34.

puration. A typical case will give a history of amenorrhea with perhaps the early symptoms of pregnancy. Suddenly there is an episode of pain associated with irregular vaginal bleeding. This may be interpreted as being due to an incomplete abortion, and curettage for diagnosis or therapy may be done. Subsequently, the patient complains of pain in the abdomen, feverishness, chills, sweats, and exhibits a septic type of temperature curve.

On examination at this time, the abdomen is distended, tender, and a mass may be palpated. On vaginal examination, uterine bleeding is found, ranging from profuse dark-red blood to brownish spotting. When the uterus can be felt, it is enenlarged and soft. A tender mass continuous with that palpated abdominally is felt to one side or behind the uterus. The temperature and pulse are elevated and septic in nature; constitutional symptoms of suppuration exist.

Laboratory findings are essentially those of hemorrhage and infection. Some degree of secondary anemia may exist, the leucocytes and polymorphonuclear neutrophiles are increased with a shift to the left. Sedimentation rates are usually rapid. The Aschheim-Zondek test is of little value as fetal death has usually occurred some time prior to infection. Decidual tissue passed *per vaginam* is strong presumptive evidence of extra-uterine pregnancy (Case 2).

In the atypical case there is often no history of amenorrhea; nor of any sudden sharp pain to indicate previous tubal rupture. Frequently, the patient does not distinguish between the pain of the rupture and that of suppuration and describes the pain as being continuous. When the infection occurs almost simultaneously with the formation of hematocele, the history is brief and in one case was less than a month in duration. When suppuration of a secondary abdominal pregnancy occurs, the history is of several months' duration. *Most constant is a history of continued irregular vaginal bleeding.*

The fever is not always septic in nature. However, some elevation of the temperature is always present. Fever, in the presence of ectopic pregnancy is not pathognomonic of infection, as the absorption of blood in non-infected cases may cause a low grade rise in temperature. In some cases, the temperature is high on admission, and over the period of a week, gradually subsides to normal, resembling the temperature curve of an acute salpingitis.

The mass varies considerably in size and consistency. In one patient, it was described as reaching the costal margin. In another, it did not extend beyond the true pelvis. It may be hard, resembling a parametrial exudate, although it is always unilateral and well defined. It may have the shape and consistency of a tubo-ovarian abscess. Occasionally, there is so much encapsulated fluid as to give the impression of an ovarian cyst. On initial examination, the uterus may not be distinguishable from the mass, but careful examination especially under anesthesia, will show the uterus to be separate. Symptoms of a partial intestinal obstruction may be found; these are usually due to an associated paralytic ileus.

In those instances in which the fetus has grown beyond the fourth month, lipiodol injection of the uterus followed by x-ray will show the fetal skeleton to be definitely outside the uterine cavity (Case 5).

DIFFERENTIAL DIAGNOSIS

As has been indicated, the symptomatology of infected hematocele is varied. However, "one cannot make a diagnosis unless he is aware that the condition exists." There are no pathognomonic signs or symptoms, but the total clinical evidence leads clearly to the diagnosis.

Perhaps the most confusing condition to be differentiated is that of the infected abortion. Both patients give a history of amenorrhea, bleeding, and abdominal pain followed by the development of a pelvic mass. The temperature curves are strikingly similar. However, postabortal parametritis is usually a bilateral infection. Its limits and borders are not well defined to palpation. It involves the rectovaginal septum and produces a "true frozen pelvis." In hematocele, the mass is unilateral and has well defined limits; the uterus on careful examination is distinct from the mass and is not "frozen" in by induration. Usually in a well developed postabortal parametritis, uterine bleeding has stopped; in the infected hematocele, *bleeding persists.* Should an intraligamentary pregnancy suppurate, the differential diagnosis from parametritis would be extremely difficult except with a most typical history.

The physical findings and temperature in an infected pelvic hematocele may resemble those of pyosalpingitis or tubo-ovarian abscess (Case 4). When the history of sudden pain is lacking, the differential diagnosis may be very difficult or even impossible. Any irregular vaginal bleeding should lead to the thought of an extra-uterine gestation.

When a considerable amount of encysted fluid is present, the diagnosis may be confused with an infected ovarian cyst (Case 8). Continued uterine bleeding after curettage, the development of fever, and the sudden onset of a cystic mass should make one suspicious of an infected ectopic.

An infected fibromyoma or infected abortion in a fibroid uterus may present diagnostic difficulties, but in cases of infected ectopic pregnancy, careful examination under anesthesia will demonstrate the lack of connection between the uterus and the tumor.

In short, the symptoms and signs that may arise, can and do resemble those of any type of pelvic infection. By keeping the syndrome of infected hematocele in mind, careful evaluation of the history and physical signs will suggest the proper diagnosis.

TREATMENT

The diagnosis of ectopic pregnancy and its early operation is now carried out in a high proportion of cases. But there will always be a few cases that escape early operation and form a fertile soil for suppuration. Mismanagement of those cases raises the mortality of ectopic pregnancy considerably. Many of these cases are not recognized as infected ectopic pregnancies and death is ascribed to pelvic abscess, sepsis, or peritonitis; whereas the mortality of simple ectopic pregnancy is from 1 to 2 per cent, that of infected ectopic pregnancy is 20 to 30 per cent.

Fortunately, the hematocele becomes encapsulated before infection occurs. It is, therefore, necessary to recognize that an infected hematocele contains virulent organisms in an ideal culture medium, well walled off, and that the escape of this pus into the peritoneal cavity may result in a general peritonitis and death. From observation of cases in the non-operative era, it is known that these abscesses point most commonly toward the rectum, vagina, and abdominal wall; fistulous discharge of fetal remnants through these organs was common. In cases pointing toward the abdominal wall, the capsule of the encysted fluid becomes merged with the parietal layer of peritoneum so that these abscesses can be opened without entering the free cavity—a circumstance which may have given rise to the mistaken belief that all these infected cases are primarily extraperitoneal in origin. Similarly, when the abscess points toward the vagina or the rectum, its wall fuses with the visceral peritoneum overlying these organs. This fusion with the peritoneum is a natural attempt to "wall off" the infected hematocele and should not be disturbed at operation.

When the abscess bulges into the vagina, colpotomy should be done. This drains the intraperitoneal abscess but does not disrupt the adhesions forming the upper wall and thereby prevents contamination of the general peritoneal cavity. If hemorrhagic pus is found, no further surgery should be attempted. In two large series reported, of 18 patients treated by colpotomy only 1 died, as compared to 7 deaths in 17 cases operated on transabdominally (13, 21).

Frequently, the infected hematocele, although it can be felt vaginally, rises out of the pelvis and points toward the abdominal wall. In this situation, drainage is most effectively secured through the abdomen. A true extraperitoneal inguinal approach is not always feasible, as is shown by Cases 1 and 7 in which it was attempted without success; subsequent intraperitoneal drainage was necessary. Simple incision and drainage at the point where the infected sac is adherent to the parietal peritoneum and abdominal wall is all that is necessary.

In all of the cases in which intra-abdominal drainage was attempted, adhesions were found between the wall of the infected sac and the peritoneum. In the future, should a patient present herself, and no adhesions exist, a two stage operation similar to that practiced for lung or liver abscess will be carried out; i.e., "packing down" to or into the peritoneum and incision into the sac 24 to 48 hours later after adhesions have been created, thereby walling off the general peritoneal cavity from the infected material. This type of treatment is not new. Parry, 1887, advised stitching the cyst to the abdominal wall in order to shut off the peritoneal cavity.

The objection to simple incision and drainage has been that convalescence is delayed and that the mass does not entirely disappear (10). Convalescence has been prolonged, but in this series there have been no fatalities with incision and drainage, and on discharge or shortly thereafter, the pelves were essentially normal. The postoperative recovery, although delayed, was less stormy than that following total excision. Should a mass be persistent and cause symptoms, it is possible that subsequent to evacuation of the pus, secondary removal could be safely accomplished.

Total extirpation of the infected hematocele, by entering the free peritoneal cavity can be successfully accomplished, but is dangerous. The contents of the cyst are septic and any spill invites generalized peritonitis. Occasionally, the contents of the sac are sterile or so low in virulence, that soiling does not produce fatal peritonitis.

It has been suggested that in those patients who are not too ill, total removal would be made safer if defervescence can be accomplished (9, 10). It is of interest that Haeusermann, who also suggests waiting until the afebrile stage, reports 5 deaths in 9 infected ectopic pregnancies operated on abdominally. However, in Case 4 which was

erroneously considered to be pyosalpingitis, and operation deferred until the temperature, sedimentation rate, and white count had reached normal limits, intra-abdominal excision was successful.

At the present time, it appears that complete excision can safely be accomplished in selected cases, yet it is more dangerous; it is contrary to good surgical principles; and it has a higher mortality and morbidity rate than does simple incision and drainage.

In this series, there were 10 cases of infected hematocele with 2 deaths, a gross mortality of 20 per cent. Four of these 10 patients were treated by colpotomy with 1 death, a mortality of 25 per cent. This death occurred in a patient who was moribund on admission and in whom autopsy revealed the presence of an already existing widespread peritonitis.

Three patients were subjected to complete or partial excision of the infected mass. One of these patients died, giving a mortality of 33 per cent. It is our impression that if this patient had had an incision and drainage without contamination of the general peritoneal cavity, her life might have been saved. The convalescence in this group was marked by severe postoperative reactions.

Three patients were treated by abdominal incision and drainage at the point of adherence of the infected mass to the abdominal peritoneum, with no deaths. In these 3 cases, an approach through colpotomy was considered dangerous. Recovery was somewhat prolonged and drainage continued over a fairly long period of time. However, on discharge, the pelves were clean. No secondary operations were necessary.

CASE REPORTS

Infected Ectopic Pregnancies

CASE 1. R. H., aged 22 years, nullipara, was admitted to the hospital, complaining of abdominal pains and vaginal hemorrhage of 8 weeks' duration. Last menstrual period was 14 weeks ago. Shortly before admission uterine packing had been used to control the bleeding. The abdomen was distended, but no masses were felt. The uterus was slightly enlarged and anterior; lying on top of the fundus and filling the entire pelvis was a globular mass. Temperature was 102 degrees; white blood cells, 26,000; polymorphonuclears, 84 per cent; sedimentation rate, 18 millimeters in 20 minutes.

With bed rest the mass grew larger and the temperature began to "spike." Extraperitoneal abdominal drainage 3 weeks after admission was unsuccessful. At laparotomy the omentum completely sealed off a hemorrhagic cyst from the general peritoneal cavity. On incision, bloody pus and placental tissue were found. Abdominal drainage was secured. Convalescence was uneventful, and she was discharged on the twenty-fourth day.

CASE 2. E. B., aged 34 years, nullipara, was admitted to the hospital with a history of spotting for 2 weeks and lower abdominal pain for 1 week. She had had no skipped periods. The abdomen was distended and tender. Slight brown vaginal discharge was present. Behind the uterus and to its left, there was a firm well defined globular mass. Temperature was 101 degrees; white blood cells, 26,000; polymorphonuclears, 93 per cent; sedimentation rate, 18 millimeters in 35 minutes. Because of a decidual cast passed *per vaginam*, a diagnosis of infected ectopic pregnancy was made. Colpotomy yielded a large amount of bloody pus which on culture showed hemolytic streptococci, staphylococci, and colon bacilli. She was discharged on the thirtieth postoperative day.

CASE 3. E. S., aged 25 years, tripara, admitted to the hospital, with vaginal bleeding of 1 month's duration and abdominal pain of 2 weeks' duration. Last menstrual period was 4 months ago. The abdomen was tender, distended, and contained a mass extending to the umbilicus. Vaginal examination showed a bloody discharge, and the pelvis was filled with a large globular mass. Temperature was 102 degrees; white blood cells, 21,000; polymorphonuclears, 82 per cent. X-ray examination showed a 4½ month fetus in the right lower quadrant. At laparotomy 3 days after admission a cystic, necrotic mass containing a macerated fetus floating in foul smelling blood was found. Excision was performed and drains were widely placed. Cultures revealed Bacillus coli. The patient died on the ninth postoperative day, apparently of peritonitis.

CASE 4. V. B., aged 35 years, nullipara, was admitted to the hospital, complaining of dark vaginal bleeding for the past month and sharp abdominal pain for the past 2 weeks. There had been no missed periods. There was marked tenderness and rebound in the right lower quadrant. There was a dirty red vaginal discharge present and a tender globular mass to the right and behind the uterus. Temperature was 104 degrees; white blood cells, 8,000; polymorphonuclears, 80 per cent; sedimentation rate, 18 millimeters in 55 minutes. Diagnosis: right tubo-ovarian abscess. Laparotomy was performed 1 month after admission. A round, hemorrhagic mass containing a small amount of pus was removed with considerable difficulty, and vaginal drains were inserted. The pathological report was ectopic pregnancy. The postoperative course was marked by distention and fever. Patient was discharged on the eighteenth postoperative day.

CASE 5. R. M., aged 38 years, secundipara, was admitted to the hospital complaining of lower abdominal pain for the past 3 weeks and vaginal bleeding for the past 2 days. There were no skipped periods. There was a firm tender mass extending to the umbilicus. Pelvic examination was not satisfactory; moderate vaginal bleeding was present. X-ray examination of the abdomen revealed a macerated fetus about the size of a 6 months' pregnancy; lipiodal injection of the uterus showed the fetus to be in the peritoneal cavity. At operation an ovoid mass containing foul smelling pus and fetal bones, attached to the left tube was found. Excision with drainage was performed. The convalescence was stormy and marked by distention, pulmonary edema, and foul drainage. Patient was discharged on the thirty-fourth postoperative day.

Infected Pelvic Hematocele

CASE 6. C. P., aged 34 years, sextipara, was admitted to the hospital, complaining of irregular vaginal bleeding and lower abdominal pain for the past 16 days. Last menstrual period was 5 weeks before admission. A tense cystic mass extended to the umbilicus. Moderate dark red vaginal bleeding was present. The uterus was masked by a large doughy mass which bulged into the cul-de-sac. Temperature was 103 degrees, white blood cells, 25,000; polymorphonuclears, 95 per cent. Colpotomy was immediately

performed, 1,500 cubic centimeters of foul smelling, chocolate colored fluid containing some pieces of necrotic tissue resembling placenta was obtained. Bacillus coli was found on culture. The patient died 36 hours later. Autopsy by the medical examiner's office was reported as pelvic abscess, fibrosanguineous peritonitis, and ruptured left tube.

CASE 7. P. B., aged 32 years, octigravida, primipara, was admitted to the hospital, complaining of amenorrhea of 2 months' duration and irregular vaginal bleeding for the past 4 days. For 2 days there had been severe abdominal pain associated with chills and fever. The abdomen was distended and rigid, with a sensation of an indefinite mass in the left lower quadrant. Slight vaginal bleeding was present. The uterus was pushed forward by a tender mass high in the left fornix. Temperature was 103 degrees; white blood cells, 16,000; polymorphonuclears, 90 per cent; sedimentation rate, 18 millimeters in 12 minutes. An extraperitoneal drainage attempted 1 week after admission was unsuccessful. Five days later she was reoperated upon transabdominally and a bluish mass adherent to the lower peritoneum was found. One liter of brown, foul smelling fluid was evacuated and drains were inserted. Culture yielded staphylococci. Pathological report was fibropurulent peritonitis with possible decidual reaction. Drainage was extremely profuse and the patient was discharged on the forty-third postoperative day.

CASE 8. G. McF., aged 22 years, mullipara, was admitted to the hospital with a history of metrorrhagia for the past 6 months. Three weeks before admission dilatation and curettage was performed elsewhere. One week later she noticed swelling of the abdomen, pain, brown vaginal discharge and fever. The abdomen contained a large cystic mass with a definite fluid wave. There was a dirty brown vaginal discharge present. A large mass bulged into the anterior fornix and pushed the uterus backward. The temperature was septic, reaching 103 degrees daily. White blood cells numbered 9,000; polymorphonuclears, 76 per cent; sedimentation rate 18 millimeters in 30 minutes. Six days later an incision at the point of adherence of the abdominal mass to the peritoneum was performed and one quart of foul bloody pus was evacuated. Cigarette drains were inserted. Aerobic cultures were sterile. Patient was discharged on the twenty-second postoperative day.

CASE 9. M. S., aged 25 years, nullipara, was admitted to the hospital, complaining of amenorrhea for 5 weeks and lower abdominal pain for 2 weeks. There was a history of pelvic inflammatory disease 2 years ago. Uterus was slightly enlarged and there was a questionable small soft mass in the left fornix. Laboratory examinations were normal. While under observation as a suspected ectopic, the patient left the hospital against advice. She was readmitted 6 days later, complaining of pain, bleeding, chills, and fever. The abdomen was tender and rigid. No abnormal vaginal masses could be felt. Temperature was 102 degrees; white blood cells, 11,000; polymorphonuclears, 77 per cent; sedimentation rate 18 millimeters in 8 minutes. A diagnosis of infected abortion was made, and conservative therapy was instituted. Ten days after admission, a mass was noted in the left hypochondrium which rapidly enlarged coincidentally with "spiking" of the temperature. Because the mass was discrete from the uterus, the diagnosis was changed to infected hematocele, and colpotomy was performed. A large amount of foul bloody pus containing pieces of necrotic tissue, was obtained. Aerobic cultures were negative. She was discharged on the eighteenth postoperative day.

CASE 10. M. D., aged 32 years, tripara, was admitted to the hospital, complaining of abdominal pain and vaginal bleeding of 1 week's duration. Last menstrual period was 3 weeks before admission. The abdomen was tender. The uterus was anterior and behind it there was a discrete tender fluctuant mass. Temperature was 102 degrees; white blood cells, 15,000; polymorphonuclears, 94 per cent. Cervical smear showed gram-negative, intracellular diplococci. Complement fixation test for gonorrhea was positive. The Aschheim-Zondek test was negative. Colpotomy was performed, and several ounces of bloody pus was evacuated. Smears of this pus showed organisms similar to gonococci. Patient was discharged on the thirteenth postoperative day.

CONCLUSIONS

1. The most common source of suppuration complicating hematocele is infection subsequent to intra-uterine manipulation. Infection may also spread from the rectum and intestines or from a co-existing salpingitis.

2. Pelvic hematocele which causes sufficient symptoms to require operation is most commonly caused by ectopic pregnancy. However, only 50 per cent of the patients presented had histological proof of extra-uterine gestation.

3. The most constant symptom is persistent and irregular vaginal bleeding. Pain, fever, history of a skipped period, and a pelvic mass may be present. The laboratory findings are essentially those of infection and hemorrhage.

4. The signs and symptoms resemble those of any type of pelvic infection and the condition is often misdiagnosed as parametritis, pyosalpinx, infected ovarian cyst, etc.

5. The blood usually becomes encysted before infection takes place. Subsequently, there is a fusion of the wall of the mass with the adjacent layer of visceral or parietal peritoneum, a circumstance which has given rise to the mistaken belief that infected hematocele is primarily extraperitoneal in nature.

6. When feasible, posterior colpotomy is the treatment of choice.

7. When the infected mass must be operated on transabdominally, simple incision and drainage at the site of adherence to the parietal peritoneum is safer and preferable to complete excision, except in selected cases.

8. Infection of pelvic hematocele causes a marked increase in the mortality rate of ectopic gestation. Many cases are not recognized and death is ascribed to pelvic abscess, sepsis, or peritonitis. In this series of 10 cases, there were 2 deaths, a gross mortality of 20 per cent.

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VARICOSE VEINS

IN the normal venous system of the lower extremity the direction of blood flow is always from the superficial to the deep system and never from the deep to the superficial. In varicose veins there exists what is usually appreciated even by the patient, a dilatation of the veins or ectasia. Among other changes is one frequently not appreciated, but far more important, namely, a flow of blood from the deep to the superficial venous system. This of course is an abnormal backflow. In incipient varicosities retrograde flow cannot always be demonstrated. It may be present and not demonstrable even though ectatic veins are easily seen. Sooner or later, however, in every case that progresses this backflow can be found unquestionably. The retrograde flow may exist only through the saphenous, a most favorable type of case to treat. However, as also may be demonstrated by tests, the backflow of blood from the deep to the superficial system may occur at various levels of the leg.

In attempting to treat varicose veins an evaluation of the circulation of the extremity both from the standpoint of arterial blood supply and of venous circulation is most important. More harm than good would result from intentional obstruction of the superficial venous circulation, when the capacity of the deep veins is already compromised by a previous thrombophlebitis. For that reason it is important to know whether the deep venous system is obstructed. It is also important to know whether there are varicosities with ectasia alone and no demonstrable backflow of blood in the saphenous, or whether there are leaks from the deep to the superficial venous system, either only through the saphenous or in addition through what are presumed to be communicating channels between the superficial and deep systems. The comparative tourniquet[1] test will demonstrate the level of leaks from the deep to the superficial venous system. Previously it was presumed that in most cases showing a retrograde flow below the main opening of the saphenous such backflow occurred through communicating channels in the calf and not in the thigh. By use of the comparative tourniquet test it has been demonstrated that when valves of the communicating veins are incompetent it is generally the communicating veins only of the thigh which are involved and not veins communicating between the deep and superficial systems in the leg below the knee. This is fortunate, for when abnormal communications exist between the deep and superficial systems below the knee the case falls into a group which is most difficult to treat.

[1]Mahorner, H. R., and Ochsner, A. A new test for evaluating circulation in the venous system of the lower extremity affected by varicosities. Arch. Surg., 1936, 33:479.

The problem of the treatment of varicose veins continues to evade complete solution. It is surprising how many methods employed today were used even before the advent of antiseptic surgery. Ligations were done by Paré; excision, at least a crude form of it, was described by Galen and Celsus. The injection of sclerosing solutions dates back to 1856. Infections and inadequate appreciation of the disturbed physiology in applying the methods in the pre-antiseptic era resulted too frequently in failures and unsatisfactory results. However, further accumulation of knowledge and more intense experience have resulted in an evolution of treatment to the status whereby an optimum result is obtained and a minimum rate of recurrence is to be expected. In the decade 1920 to 1930 following the advent of newly described safe sclerosing solutions, the injection therapy for varicose veins was widely used and approvingly and intensely acclaimed. At the beginning of the present decade, reports of series with a high percentage of unsatisfactory results from sclerosing therapy alone when observed over a period of several years, including cases in which an end point in treatment could not be reached, and together with announcements by a number of authors of more satisfactory results following ligation and transsection of the vein with simultaneous injection of a sclerosing solution, brought about an entirely new trend in the management of these cases. Only in the last two decades has it been fully realized that not the vein itself, but the abnormally high pressure existing therein, is largely responsible for the symptoms and complications of varicosities. This slowly impressed the necessity of utilizing the best permanent mechanical means of alleviating the abnormal increase in pressure. The best permanent mechanical measure appears today to be transsection and ligation of the vein to prevent the retrograde flow and to interrupt the height of the column of fluid, together with the injection of sclerosing solution. The simultaneous ligation and injection of sclerosing solution has been shown in large series to be relatively safe though not entirely free of danger. It is safe enough to justify its use, in those cases in which a Brodie-Trendelenburg reaction shows that the valves of the saphenous system are incompetent. It is only by the relief of this backflow and back pressure, by ligating and sectioning the vein, and by reducing the lumen of the vein by the use of a sclerosing solution, that good immediate and permanent results can be expected in a high percentage of cases.

No matter what method of therapy is used for varicose veins, one cannot expect to cure entirely the tendency of the patient to develop varicosities. Thus recurrence will probably ensue under best therapeutic management in approximately 15 per cent of the cases. On the other hand, even though recurrences come there has been some relief in the interval and usually the recurrences are less severe. If patients never entirely neglect varicose veins something further can always be done to prevent the occurrence of complications, such as, pigmentation, induration, dermatitis, and ulceration, which inflict such restrictions and suffering on the patient. It has never been definitely proved whether the ectasia or dilatation of the veins begins in the periphery, that is, in the veins of the calf, or in the intracutaneous veins, and progresses centrally or whether there is a primary dilatation at the site of the valves with incompetence, increased pressure, and resulting ectasia in the more distal radicles. Thus, the pathogenesis of varicosities is not accurately known. For this reason one cannot expect to cure the disease entirely by correcting the abnormal physiology through relief of the back pressure by ligation and section of the saphenous vein. Recurrence

or persistence of varicose veins may not always be attributable to varicosities or to the tendency to form them. Improper application of the principles involved in surgery for varicosities undoubtedly is a factor in many recurrences. Ligations below incompetent collateral channels permit the re-establishment of a saphenous vein with scarcely less vicious backflow than previously existed. Thus veins must be ligated at such levels that maximum interruption of retrograde flow and minimum tendency to re-establish channels results.

Much can be accomplished and is being accomplished for cure of varicose veins. Improvements in therapy are still being made and appreciated. The progress of the disease is at least in some individuals self-limiting and in these surgical measures can correct to a very satisfactory extent the damage already done. Surgical measures, however, cannot stay the progress of the disease in some patients, i.e., surgery cannot remove entirely the tendency to form new varicosities. The greatest advance of course would come with a solution of the cause and a method of alleviating it. That would be the most certain insurance against recurrence.

HOWARD MAHORNER.

A PLEA FOR RESPECT FOR THE TISSUES OF THE CENTRAL NERVOUS SYSTEM

UNTIL the turn of this century, the surgery of the central nervous system was to all intents and purposes, a closed book. Then, largely through the brilliance and stimulation of the lately mourned Harvey Cushing, it began a period of what almost may be described as one of riotous expansion. Nothing is now too difficult to attack and technical limitations are very nearly defined by the question as to whether an area to be invaded or excised en route to disease, is essential to life. Diagnostic methods have kept apace, chiefly in conjunction with the x-ray, and chemical therapeusis, like the use of alcohol, has assumed great boldness.

But, perhaps this record of achievement is a little marred by an accompanying contempt or indifference toward the brain and spinal cord which it may have bred in the minds of some of the profession. One detects at times a lack of appreciation of the fact that these structures are supplied an individual in full complement to start with, and that not only cannot one single damaged cell be replaced, but even healing, beneficent elsewhere, is noxious here. Healing by scar to close a gap in bone or skin or muscle is a saving property. The same process in a viscus or a gland is of no moment because there is essential cellular tissue to spare in these organs. But in the brain or spinal cord, scar from injury or inflammation, can only interfere with blood supply and function of contiguous normal territory.

To be specific: Lipiodol is a substance of great value. It is radio-opaque, and its use in certain rather rare instances may supply needed critical information. The recent emphasis upon the relative commonness of protrusion of the intervertebral disc, however, has taken it away from its exclusive use by neurosurgeons and has led to indiscriminate utilization in many sporadic cases in which it is not indicated, and indeed is harmful. Anyone who has had perforce to dig about in the soggy mess which is the cauda equina of some unfortunate in whom five or ten cubic centimeters of lipiodol had been optimistically injected a year or two previously will understand this statement. Not only is the original disease still present, but a chronic, adhesive, chemical inflammation of the caudal roots has been engrafted upon

it. Happily, myelography with air, is rapidly replacing the use of lipiodol in this large group of cases.

During the 1930's the use of alcohol in the always difficult problem of the control of pain has come into prominence. Dogliotti's daring suggestion that absolute alcohol be placed in the thecal sac itself for painful afflictions of the pelvis and lower extremities has frequently had such spectacular results that some have imagined the procedure to be a panacea, unattended by risk. As a matter of fact, the judgment of what, if anything, is to be done for the multitudinous types and sites of pain calls for the greatest exercise of experience and neuro-anatomical knowledge. Certainly, to elect to inject a substance like alcohol directly into the spinal fluid, with the attendant risk to conus, cauda, and arachnoid, should be regarded as a major clinical decision. One wonders what will happen to these structures in ensuing years, when the inevitable fibrosis initiated by incautious or unwarranted injections progresses.

Even the neurologists and neurosurgeons, whose creed it is to guard the sacred character of nervous tissue, seem at times to be carried away in the intoxication of an operative *tour de force*. One hears them glibly remarking that the first step in removing an acoustic neuroma is to amputate a good share of cerebellar hemisphere—routinely and without even considering in a given case the possibility of a more conservative exposure; or that expediency in the approach to a hemispheric or ventricular lesion automatically entails the discard of a quantity of normal brain tissue. Apparently annoyed by all which gets in their path, they excise it and thereby bring the whole problem to a conclusion.

And finally, the psychiatrists, supposedly concerned with the highest intricacies of human behavior, do not stop with the induction of the most terrific of convulsions, but actually to be found among them, are those who advocate, for ordinary periodic mental depression, the empiric mutilation and destruction of cerebral tissue hither and yon in the frontal lobes.

In all this enthusiasm, it is well not to lose sight of the inexorable law that there is no regeneration of the tissues of the central nervous system. In any procedure undertaken involving it, the axiom should be that the chances of benefit must preponderantly outweigh the harm of injury. When in doubt—don't risk it! ERIC OLDBERG.

ACROSS THE EDITORIAL DESK

SINCE the beginning of SURGERY, GYNECOLOGY AND OBSTETRICS thirty-five years ago, it has been the policy of the Editors to look upon the journal as a forum wherein men in practice could express the results of their clinical or experimental investigations.

Many times the Editors have been in disagreement with the conclusions expressed and, now and then, with the methods used to investigate the problem under consideration. However, honesty of purpose, frankness in the expression of methods used and the results obtained, and a philosophy often expressed by Kanavel ("you may not agree with him, but don't forget there may be something in it"), have been some of the principles upon which manuscripts have been chosen for publication. We believe that our readers are able to form their own opinions about an operative method or a conclusion reached from a study of clinical cases, and if they disagree violently enough perhaps another piece of work will be stimulated.

MANY comments have reached the author and the Editors concerning the interesting method of presentation used by JOHNSTON, of Toronto, in his paper entitled, "The Treatment of Uterine Prolapse." The text material, if you recall, was brief but the legends accompanying the numerous line drawing illustrations were full and consisted of just about what the author would tell you if you were watching over his shoulder as he performed the operation. Well made drawings or photographs tell a story in a way that sentences, no matter how well written, may fail to do. It has been our belief for a long time that most of the manuscripts published are far too long and verbose, just as most presentations before medical societies consume too much time. The method, materials used, and the important results of a research problem can usually be presented in ten or fifteen minutes at the most.

THERE is a great deal to be said for the statement that medical papers are written according to an outline; that they are often dull when they could be made interesting and that doctors as a group demand good writing in the fiction they read but spend little time or thought upon their own literary efforts. The time is coming when we shall see textbooks of medicine written to interest the reader, whether he be student or practitioner, in the story of the disease. Bald descriptions divided into compartments, which are labelled "Etiology," "Pathology," "Diagnosis," "Prognosis," "Treatment," and in which inaccurate statements pass from one book to another and from year to year are rapidly becoming passé.

Each of us is likely to believe that writing for the other fellow, whom we believe does it well, is an easy matter; that he sits down and dashes off a well rounded phrase or sentence with the greatest of ease. So many writers, not doctors, have entered strong denials that it seems trite to bring the matter up again. However, we recently have seen a letter from Harvey Cushing to a colleague of his of many years' standing, in answer to a letter complimenting him upon his facility for saying a thing well on paper and asking him to tell just how it could be acquired. With the permission of the doctor to whom the answer was sent we are quoting the letter below:

"But my dear man, there is no secret whatever about writing. It is a laborious task at best.

"I have no tricks of the trade that I can hand on to you. In fact, there are no tricks to hand on to anyone. My own method is probably the most laborious imaginable. I always write everything out, long-hand. My secretary, who can read my abominable writing almost better than I can myself, then copies it in three spaces so that I can write between the lines. She then copies it again with groans and I proceed to knock out unnecessary words and change it around so that it is unrecognizable. Then she, with more groans, copies it a third time and this process may go on until both of us are heartily sick of it. I would hate to say how many drafts we have had of every chapter in the meningioma book, some fragments certainly twenty years old.

"So far as I can see, no one writes easily. Those who appear to do so are the ones who have spent the most *Geduld und Thranen* in the process. People who undertake to dictate their ideas or, still worse, to talk them into a dictaphone are likely to find it poor stuff. I once did this myself and then listened in with such chagrin that I never attempted to do so again.

"With much power to your pen and elbow, I am"

THE SURGEON'S LIBRARY

REVIEWS OF NEW BOOKS

IN the treatise, *Physiology of the Uterus*,[1] containing 450 pages, of which 132 are devoted to a bibliography with 1,190 references, Reynolds has compiled a comprehensive review of the literature pertaining to the physiology of the uterus with an attempt to correlate the facts adduced therefrom.

The book represents a tremendous amount of work on the part of the author, but its chief value is to be found in the references it contains rather than in the abstracted material, since the original treatise on the various phases of this subject would be more desirable to the interested student. The author is represented in the bibliography by 30 contributions to the literature on this subject.

CHESTER C. DOHERTY.

THE new text on phonocardiography entitled, *Heart-Sounds in Normal and Pathological Conditions*[2] written by two well known South American investigators, suitably presents the results of their extensive studies. The translation does not detract from the original exposition.

The subject matter is well covered including historical information, methods, normal findings, as well as a wide diversification of pathological states. These include the valvular lesions, gallop rhythm, A-V block, bundle branch block, pulsus alternans, extrasystoles, and auricular fibrillation. The bibliography is extensive with both author and subject indices. The illustrations are well selected and clear in detail.

One is left with the impression that the method is valuable for further investigation of many points of abnormal cardiac physiology; however, one is also inclined to doubt whether the registration of abnormal heart sounds is practical for present day office and hospital practice. For those who are interested in the registration of heart sounds, this book is a worthwhile text. CHAUNCEY C. MAHER.

A TEXTBOOK which can be especially recommended to any student or postgraduate in otolaryngology is *Diseases of the Nose and Throat*,[3] by Charles J. Imperatori and Herman J. Burman, and it would be of great value to the practicing physician as well.

The authors answer many questions helpful to the postgraduate by presenting an up-to-date outline which covers the subject completely and in a manner quickly comprehended. The first chapters relate to the necessary equipment for the office of an otolaryngologist. They also stress the value of a meticulous routine examination with the proper technique of treatment. This is all placed before the reader in a most comprehensive manner through the excellent illustrations which picture the operative procedures on the nose and throat as well as the various diseases.

The pathology is well covered and the symptoms, diagnosis, treatment, and causation are well arranged. The anatomy, physiology, and development of the nose and throat have not been neglected and are discussed in the same understanding manner.

Relative to diseases of the sinuses, complications such as orbital infections, which occur in conjunction with sinusitis, are fully explained as is also the importance of sinusitis acting as a focus of infection and causing manifestations of general systemic diseases. Indications, contra-indications, interpretation, and technique of endoscopy in the branch of laryngology are revised and described in detail.

Included also are articles of more recent development and consideration in relation to the nose and throat, such as physical therapy, diseases of the oral cavity, acute laryngotracheobronchitis, and asthma.

GEORGE F. MCINTYRE.

THE excellent book, *Positioning in Radiography*,[4] is the most complete treatise on the subject ever published. Positioning is one of the most important features of any roentgenographic examination. The author has succeeded in illustrating correct positioning in a unique manner by photographing living models. Roentgenograms resulting from such positions are reproduced in the negative phase. The positions are described in a concise and practical manner, and the correct positioning for the examination of every part of the body has been covered. Adequate exposure data are given for each examination. Line drawings and photographs of dried bones are frequently used for illustrative purposes. The book does not include a discussion of electrical equipment or roentgenographic interpretation.

Some of the more recent advances in roentgenographic technique such as kymography, tomography, and cineradiography are discussed. The grade of paper, printing, and illustrations are excellent. The author and publisher are to be congratulated for presenting this superior volume. It will undoubtedly receive a warm welcome both from roentgenologists and from physicians and surgeons generally.

EARL E. BARTH.

[1] PHYSIOLOGY OF THE UTERUS; WITH CLINICAL CORRELATIONS. By Samuel R. M. Reynolds, M.A., Ph.D. New York and London: Paul B. Hoeber, Inc., 1939.

[2] OXFORD MEDICAL PUBLICATIONS. THE HEART-SOUNDS IN NORMAL AND PATHOLOGICAL CONDITIONS. By Oscar Orías, M.D., and Eduardo Braun-Menéndez, M.D. London, New York, and Toronto: Oxford University Press, 1939.

[3] DISEASES OF THE NOSE AND THROAT. By Charles J. Imperatori, M.D., F.A.C.S., and Herman J. Burman, M.D., F.A.C.S. 2d ed. Philadelphia, London, and Montreal: J. B. Lippincott Co., 1939.

[4] POSITIONING IN RADIOGRAPHY. By K. C. Clark, F.S.R. St. Louis: The C. V. Mosby Co., 1939.

IN the fourth edition of the volume, *A Descriptive Atlas of Radiographs*,[1] the author has rewritten much of the subject matter and has added considerable material particularly to the section on the respiratory system. The chapter dealing with the history of radiodiagnosis has been brought up to date.

The purpose of the book is "to show the immense possibilities of x-rays." An attempt has been made to portray the normal and abnormal conditions, rather than the rarities, which are encountered in practice. The reproductions, all of them in the positive, are often accompanied by line tracings with adequate legends and often a concise clinical note.

The volume is somewhat larger than the previous edition and contains 43 additional illustrations. The book is primarily intended for the use of the clinician who desires to know what aid roentgenographic examinations can give him in making an accurate diagnosis. Radiologists, however, as well as clinicians, should find this volume useful in their practice.

EARL E. BARTH.

THE book entitled *Gynæcology*,[2] by Herbert H. Schlink, is designed for senior medical students. It reviews gynecology as a group of lectures would. The chapter on anatomy is sound and well presented. The discussion of symptoms of gynecological disease is useful and well done. Physiology and endocrinology are fairly well presented, yet there is a lack of full appreciation of endocrinology and of the value of hormones as therapeutic agents. Dr. Schlink obviously does not have faith in their use except in the menopause. The sections on infections and inflammations are instructive and clear. Malignant disease is covered carefully but not too fully. The chapter on operative gynecology is not satisfactory for a gynecologist or surgeon but should do for the student.

The Schlink enucleator as a method of coning the cervix seems heavy and complicated. Condemnation of all suspension operations except the Alexander and the Gilliam is not generally accepted and is evidence that Dr. Schlink is presenting his own opinions. All will not agree with him. The chapter on postoperative care does not mention the use of the Levin tube or any of Wangensteen's excellent work on intestinal obstruction. Some of the postoperative care advocated is antiquated, such as using a trocar in 1 to 3 areas to remove the septic fluid in an obstructed intestine. The chapters of the book dealing with anatomy, physiology, symptoms, infections, etc., are very good but those on treatment and postoperative care could be improved upon.

The book itself is excellent: good paper, good type, and very good reproductions have been used. It can be recommended to students and to general practitioners but not to operating gynecologists and surgeons.

JOE V. MEIGS.

[1] A DESCRIPTIVE ATLAS OF RADIOGRAPHS; AN AID TO MODERN CLINICAL METHODS. By A. P. Bertwistle, M.B., Ch.B., F.R.C.S.(Ed.). 4th rev. enl. ed. St. Louis: The C. V. Mosby Co., 1939.

[2] GYNÆCOLOGY. By Herbert H. Schlink, M.B., Ch.M.(Sydney), F.R.A.C.S. Sydney and London: Angus & Robertson, Ltd., 1939.

THE treatise of 346 pages entitled *Cancer of the Colon and Rectum*,[3] by Fred W. Rankin and A. Stephens Graham not only represents the results of the extensive experience of the authors, but also utilizes the experiences of other men of prominence in the field of cancer of the colon and rectum. There is no one whose interest and experience in this field of surgery better fits him for such a task than that of the senior author.

The book is divided into 3 main sections. Part I is headed "General Considerations." In this is to be found an excellent description of the anatomy and physiology of the large bowel, with particular attention to the practical aspects of the blood supply and lymph drainage. Incidence, pathology, symptoms, and differential diagnosis are included in this section. Part II is given over to treatment. In this section are discussed the factors influencing the operability and prognosis of the different lesions, the hospital mortality and end-results, and the indications for the various types of operation for lesions situated in the different segments of the bowel and the varying degrees of obstruction. There is also a concise but conservative and well written chapter by Dr. Fred M. Hodges on the rôle of radiotherapy, as well as a complete discussion of the pre-operative and post-operative management of these patients as carried out by Dr. Rankin and Dr. Graham. The final section, Part III, is devoted to a discussion of the various technical procedures which are more generally recognized in the management of the conditions under discussion.

The book is well illustrated. The diagrams are for the most part simple, black and white sketches, easily interpreted, which illustrate well the various technical points.

In spite of the splendid general plan of presentation and the clear wording of the text, there is too much repetition which is particularly tiring to the person reading the treatise in continuity. It is disappointing that the excellent work of David and Gilchrist on the lymphatics in relation to cancer of the rectum has not been included in this monograph. It is also to be regretted that a procedure which has received so much popular acclaim as Devine's defunctioning operation should not be described in such a work: and it would seem to the reviewer that the time and space given to the treatment of such conditions as ulcerative colitis, megacolon, and tuberculosis of the colon have no place in a book which the introduction states is specifically on cancer of the colon and rectum.

We must, on the other hand, sincerely commend the authors for their definite and clear-cut position in favor of a radical procedure for carcinoma of any segment of the bowel, and for their insistence that a permanent colostomy is still the backbone of an adequate operation for cancer of the rectum.

[3] CANCER OF THE COLON AND RECTUM. ITS DIAGNOSIS AND TREATMENT. By Fred W. Rankin, B.A., M.S., M.D., Sc.D., F.A.C.S., and A. Stephens Graham, M.D., M.S. (in Surgery), F.A.C.S. Springfield and Baltimore: Charles C. Thomas, 1939.

Let the reader of this review not be misled by the criticisms here given. It is probably the most comprehensive and complete treatise on cancer of the large bowel available today and will serve as an excellent guide or reference book to any surgeon regardless of his experience.

LELAND S. MCKITTRICK.

THE eighth edition of the *Textbook of Bacteriology*,[1] by Hans Zinsser and Stanhope Bayne-Jones, has been thoroughly revised and brought up to date, and the same high degree of excellence is maintained in this book that characterized the former editions.

The latest important work and discoveries in bacteriology and immunology are included in this edition together with a fair evaluation and critical discussion of each. In all their discussions the authors are conservative; but when the evidence seems to warrant it, they have not hesitated to express an opinion. On the theoretical and controversial subjects they have presented all the evidence and arguments and have fairly but critically discussed them.

The material has been well selected, digested, and arranged to give the student a broad knowledge of the fundamentals of bacteriology and immunology and at the same time point out the practical application of these sciences to medicine and sanitation.

As a textbook for medical students it serves its purpose well, but it might be more helpful if greater emphasis were placed on diagnosis. If the information through the text concerning the laboratory diagnosis of an infectious disease were brought together and briefly stated under that heading, it would, we believe, be a definite aid to the student. The chapter on pathogenic protozoa has been omitted. The authors, we think, were wise in so doing. Protozoology has grown to the proportion of a separate science and there is no good reason why it should be included in a textbook of bacteriology.

The book is somewhat reduced in size but without injuring its value in the least. It is one of the few good textbooks of medical bacteriology.

A. W. WALKER.

THE short monograph by Leclerc and Moreau entitled *Les Moignons Douloureux*[2] concerning the nature and choice of treatment of painful amputation stumps is a plea for surgical relief from the constant agonizing distress found in approximately 10 per cent of all patients with amputated extremities. Such painful stumps are frequently the results of accidents of occupation and everyday life; therefore, an effort should be made to obtain relief for the patient both from the standpoint of comfort and that of rehabilitation.

The experience of the authors is based on 12 patients, 8 of whom were treated surgically with promising results. They divide painful stumps into 2 main classes: (1) the "spinal" type, in which the patient suffers intense, well localized, paroxysmal pain in a definite anatomical distribution, frequently in a phantom limb, with or without local stimulation or irritation of the neuroma; and (2) the "sympathetic" or autonomic type, in which the pain is less acute, but more constant and perhaps more distressing, with all sorts of itching, prickling, burning, and other forms of exhausting painful paresthesias, caused either by local stimulation or by changes in temperature, humidity, vascularity, emotional stress, and various other factors. Actually, however, the authors concede that by far the greater number of cases are a mixture of these 2 primary types.

Various forms of treatment are considered, including dissection and removal of the neuroma, alcohol or phenol injection of the nerve ends, section of the affected nerve trunk with immediate suture of the sectioned ends, periarterial sympathectomy of the vessels leading to the affected stump, novocain injections into the nerve and neuroma, novocain infiltration of the upper thoracic chain ganglia, lumbar sympathectomy, stellectomy, cordotomy, and posterior rhizotomy. No cut and dried rule can be formulated in the selection of the type of treatment for any particular case. Section of the nerve with immediate suture is frequently effective in the "spinal" type; removal of the appropriate ganglia and chain is usually advisable in the "sympathetic" type; and a combined operation is likely to be most effective for the mixed type of pain. Operative indications may be arrived at most often by preliminary novocain infiltration of the corresponding sympathetic ganglia.

JOHN MARTIN.

A SUCCINCT, adequate, well documented review of present knowledge concerning tuberculosis is the work entitled *Pulmonary Tuberculosis: Pathology, Diagnosis, Management and Prevention*,[3] by George G. Kayne, Walter Pagel, and Laurence O'Shaughnessy. I know of no better book on the subject in the English language. It is one of the few written by the younger and modern generation of phthisiologists, men who have grown up in the atmosphere of the newer knowledge of the pathogenesis, diagnosis, and treatment of the disease.

It is significant that the author of the excellent sections on pathogenesis is an expatriate German, and that the chapters on surgery were written by an Englishman who secured his training from Sauerbruch. The German influence is obvious and certainly accounts for many of the book's good points and probably for its necessarily bad ones.

Although Germans have made very few of the important discoveries in the field of tuberculosis,

[1] A TEXTBOOK OF BACTERIOLOGY; THE APPLICATION OF BACTERIOLOGY AND IMMUNOLOGY TO THE ETIOLOGY, DIAGNOSIS, SPECIFIC THERAPY AND PREVENTION OF INFECTIOUS DISEASES FOR STUDENTS AND PRACTITIONERS OF MEDICINE AND PUBLIC HEALTH. By Hans Zinsser, M.D., and Stanhope Bayne-Jones, M.D. 8th rev. ed. New York and London: D. Appleton-Century Co., Inc., 1939.

[2] LES MOIGNONS DOULOUREUX. By Frédéric P. Leclerc and Pierre Moreau. Paris: Louis Arnette, 1939.

[3] OXFORD MEDICAL PUBLICATIONS. PULMONARY TUBERCULOSIS; PATHOLOGY, DIAGNOSIS, MANAGEMENT AND PREVENTION. By George Gregory Kayne, M.D., M.R.C.P., D.P.H., Walter Pagel, M.D., and Laurence O'Shaughnessy, M.D., F.R.C.S. London, New York, and Toronto: Oxford University Press, 1939.

they have been quick to take up new ideas and are thorough in their development and popularization. This has been a great service and it has been performed so successfully that the names of German followers have often become greater than those of the original observers. Thus Ghon has given his name to the discovery made by Parrot and Kuss. Bard's tiny book on chronic hematogenous tuberculosis has been overshadowed by the greater volumes of Neumann. The early infiltrate, first recognized by Wessler, Jackes, and Bezancon has been taken over pretty thoroughly by Assmann and Raedeker; and in collapse therapy the names of Brauer and Sauerbruch are almost greater than those of Carson, Forlanini, and Murphy.

Because of this prolific scholarship and clinical investigation, Germany, prior to 1934, was the center of discussion of theories of tuberculosis and was the source from which they were distributed throughout the world. If there was a defect in this work, it was in the direction of overtheorization and in a tendency to decide upon matters on which final judgment was impossible.

I do not mean that this book is overly dogmatic. I do mean that the authors are conversant with the many conflicting theories concerning all phases of tuberculosis. In any work on so uncertain and controversial a subject, the experienced reader will encounter many statements with which he disagrees. Emphasis should be put upon the fact that many investigators attribute to exogenous reinfection a greater rôle than does Pagel. The thoracoplasty described in the book is the old Wilms-Sauerbruch paravertebral operation performed in 1 or 2 stages. Although more recent modifications of the procedure are mentioned and described, the impression is given that the older operation is still the standard. This certainly is not the present attitude of the majority of phthisiologists and thoracic surgeons throughout the world. The Wilms-Sauerbruch operation produced not more than 40 per cent of cures. In many hands the more extensive modern operations have increased this incidence to 80 per cent. These are minor criticisms and do not detract from the excellence of the whole book. The surgical section of the book would be found more enjoyable were one not again confronted with the old Sauerbruch illustrations with which he has been familiar for the past 15 years.

JEROME R HEAD.

BOOKS RECEIVED

Books received are acknowledged in this department, and such acknowledgment must be regarded as a sufficient return for the courtesy of the sender. Selections will be made for review in the interests of our readers and as space permits.

INDUSTRIAL HYGIENE. By Various Authors. Edited by A. J. Lanza, M.D., and Jacob A. Goldberg, M.A., Ph.D. New York, London, and Toronto: Oxford University Press, 1939.

TRANSACTIONS OF THE SIXTIETH MEETING OF THE AMERICAN SURGICAL ASSOCIATION; Held at the Homestead, Hot Springs, Va., May 11, 12, 13, 1939. Vol. 57. Edited by Walter Estell Lee, M.D. Philadelphia: J. B. Lippincott Co., 1939.

GRUNDLAGEN DER SCHWANGERENERNAEHRUNG; PRAKTISCHE RICHTLINIEN UND VORSCHLAEGE FUER EINE DIAETETISCHE GESUNDHEITSFUEHRUNG DER SCHWANGEREN. By Dr. med. Habil. G. Gaehtgens. Dresden and Leipzig: Theodor Steinkopff, 1940.

ETIOPATOGENIA DA PRENHEZ ECTOPICA. By Fradique Corrêa Gomes. Pôrto Alegre, Brazil: Livraria Do Globo, 1939.

AN INTRODUCTION TO GASTRO-ENTEROLOGY. Being the Third Edition of *The Mechanics of the Digestive Tract*. By Walter C. Alvarez, M.D. New York and London: Paul B. Hoeber, Inc., 1940.

CARDIOVASCULAR-RENAL DISEASE; A CLINICOPATHOLOGIC CORRELATION STUDY EMPHASIZING THE IMPORTANCE OF OPHTHALMOSCOPY. By Lawrence W. Smith, M.D., Edward Weiss, M.D., Walter I. Lillie, M.D., Frank W. Konzelmann, M.D., and Edwin S. Gault, M.D. New York and London: D. Appleton-Century Co. Inc., 1940.

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